KOPIO
WBS Dictionary

WBS Number	Descriptio
1.2	**Key Related Milestones** This is a list of key project milestone dates.

WBS Number	Descriptio
1.2.1	**KOPIO Vacuum Subsystem**
1.2.1.1	**U/S Vacuum Decay Vessel**
	The scope of effort is the engineering, design and procurement of the upstream composite material decay vacuum vessel internal to the Photon Veto Detector. It includes a pre-construction funded prototype effort along with a multi-phase
design,	
	protot...
1.2.1.1.1	**System Development, Prototype & Test**
	This is a pre-construction System Development effort to produce (5) 1/5 scale prototype vessels. The vessels will be
tested	
	to failure as a QA of FEA buckling analysis. This includes the cost of engineering, design, and travel as detailed and
vendor	
	cost through contr...
1.2.1.1.1.1	**Engineering**
1.2.1.1.1.2	**Design**
1.2.1.1.1.3	**Procurement (KOMPOZIT)**
1.2.1.1.1.4	**Acceptance Test**
1.2.1.1.1.4.1	**Travel**
1.2.1.1.2	**Vessel Design and Procurement**
	This a multi-phase engineering and procurement effort to design, prototype and test both scale and full scale composite vessel designs leading to procurement of final operational vessel. Basis of estimate; engineering estimate for engineering and desig...
1.2.1.1.2.1	**Phase 1 (1/5 Scale) Prototype & Test**
	This task calls for the mature engineering, design and procurement of (5) 1/5 scale u/s decay vacuum vessels to be tested for structural stability. It requires a complete design effort and analysis of the vacuum vessel based on geometry required
to	
	acc...
1.2.1.1.2.1.1	**Engineering**
1.2.1.1.2.1.2	**Design**
1.2.1.1.2.1.3	**Procurement (KOMPOZIT)**

WBS Number	Descriptio
1.2.1.1.2.1.4	**Acceptance Test**
1.2.1.1.2.1.4.1	**Travel**
1.2.1.1.2.2	**Phase 2 (Full Scale) Prototype & Test**
	This task calls for the final engineering, design and procurement of full scale u/s decay vacuum vessels to be tested for structural stability. It requires a complete design effort and analysis of the vacuum vessel based on geometry required to accomod...
1.2.1.1.2.2.1	**Engineering**
1.2.1.1.2.2.2	**Design**
1.2.1.1.2.2.3	**Procurement (KOMPOZIT)**
1.2.1.1.2.2.4	**Acceptance Test**
1.2.1.1.2.2.4.1	**Travel**
1.2.1.1.2.3	**Phase 3 (Final) Vessel**
	This task calls for the engineering, design and procurement of the operational u/s decay vacuum vessel and testing for structural stability and vacuum performance. It requires engineering and design effort and analysis of the vacuum vessel
as	oversight...
1.2.1.1.2.3.1	**Engineering**
1.2.1.1.2.3.2	**Design**
1.2.1.1.2.3.3	**Procurement (KOMPOZIT)**
1.2.1.1.2.3.4	**Acceptance Test**
1.2.1.1.2.3.4.1	**Travel**
1.2.1.1.2.3.5	**Fabrication**
1.2.1.1.2.3.5.1	**Feed-thru Support Rings**
1.2.1.1.2.3.5.2	**Installation Fixtures**

WBS Number	Descriptio
1.2.1.2	**Vacuum Transitions**
	The scope of effort includes both an internal high vacuum membrane for the u/s decay vessel and vacuum windows both u/s & d/s of the vessel. The membrane will define the boundary between high vacuum for the neutral beam and rough vacuum for the Charged...
1.2.1.2.1	**Vacuum Transition Membrane**
1.2.1.2.1.1	**Prototype**
	This is an engineering estimate of the scope of effort required to produce a working prototype of an internal vacuum membrane, which is a flexible vacuum bag in a vacuum vessel. There is time allotted for engineering, design,
procurement of	
	materials and...
1.2.1.2.1.1.1	**Engineering**
1.2.1.2.1.1.2	**Design**
1.2.1.2.1.1.3	**Procurement**
1.2.1.2.1.1.4	**Assemble and Test**
1.2.1.2.1.2	**Operational Membrane**
	This is an engineering estimate of the scope of effort required to produce a working model of an internal vacuum
membrane,	
	which is a flexible vacuum bag in a vacuum vessel. There is time allotted for engineering, design, procurement of
materials	
	and fix...
1.2.1.2.1.2.1	**Engineering**
1.2.1.2.1.2.2	**Design**
1.2.1.2.1.2.3	**Procurement**
1.2.1.2.1.2.4	**Fabricate and Test**
1.2.1.2.2	**U/S & D/S Transition Windows**
	This is an engineering estimate for the engineering, design, procurement of materials and parts, and fabrication of the u/s
&	
	d/s vacuum windows of the u/s decay vessel.

WBS Number	Descriptio
1.2.1.2.2.1	**Engineering**
1.2.1.2.2.2	**Design**
1.2.1.2.2.3	**Procurement**
1.2.1.2.2.4	**Fabrication**
1.2.1.3	**D4 Vacuum Box**
and	This is an engineering estimate for the engineering, design, procurement of materials and parts, and fabrication of the D4 vacuum box. This vacuum box is located in the magnetic gap of the D4 sweeping magnet d/s of the Calorimeter Detector u/s of t...
1.2.1.3.1	**Engineering**
1.2.1.3.2	**Design**
1.2.1.3.3	**Procurement**
1.2.1.3.4	**Fabrication**
1.2.1.4	**Downstream Veto Vacuum Tank**
	This is and engineering estimate for the engineering, design procurement of materials and parts, and fabrication of the d/s Veto Vacuum Tank. This is a large volume vessel with internal veto counters that can be of a heavy structural design for bucklin...
1.2.1.4.1	**Engineering**
1.2.1.4.2	**Design**
1.2.1.4.3	**Procurement**
1.2.1.4.4	**Fabrication**
1.2.1.4.5	**Sub-assembly**
1.2.1.5	**Vacuum Pumping Station**

WBS Number	Descriptio
	This is an engineering estimate from the C-A Vacuum Group for the engineering, design, procurement, fabrication, unit assembly, and test of the decay volume vacuum pumping station. It will also include all piping connections, controls, and interlocks f...
1.2.1.5.1	**Engineering**
1.2.1.5.2	**Design**
1.2.1.5.3	**Procurement**
1.2.1.5.4	**Fabrication**
1.2.1.5.5	**Sub-assembly**
1.2.1.6	**Management Activities**
develop, responsible	This is an engineering estimate for the management of this subsystem. It calls for scientist and project engineer to implement, manage, and report on the monthly activities of all resources involved in this subsystem. The will be f...
1.2.1.6.2	**Manager**
1.2.1.6.3	**Engineering**
1.2.1.6.4	**MSTS**
1.2.1.7	**Management Activities**
develop, responsible	This is an engineering estimate for the management of this subsystem. It calls for scientist and project engineer to implement, manage, and report on the monthly activities of all resources involved in this subsystem. The will be f...
1.2.1.7.2	**Manager**
1.2.1.7.3	**Engineering**
1.2.1.7.4	**MSTS**

WBS Number	Descriptio
1.2.2	**Preradiator**
WBS	The Preradiator consists of 32 modules, each containing eight layers of dual coordinate drift chambers and nine layers of scintillator, with all necessary electronics for read out and data transmission. The effort is distributed between Chamber System (1.2.2.1), scintillator system (1.2.2.2), electronics (1.2.2.3), mechanics (1.2.2.4) and the photon veto system (1.2.2.5), and the effort necessary to design, prototype, fabricate, install, and commission the Preradiator system. This is a summary level. Detail description and cost estimation are completed at lower levels.
1.2.2.1	**Chamber System**
summary	The chamber system consists of 256 dual coordinate drift chambers and associated electronics for read out. This WBS describes the effort necessary to design, prototype, fabricate, and assemble the Chamber system. This WBS is a level. Detail description and cost estimation are completed at lower levels.
1.2.2.1.1	**Chambers**
description	The 256 dual coordinate drift chambers will be fabricated at TRIUMF. This WBS describes the effort necessary to design, prototype, fabricate, and assemble the Chambers into Preradiator Modules. This WBS is a summary level. Detail and cost estimation are completed at lower levels.
1.2.2.1.1.1	**Design**
1.2.2.1.1.2	**Prototype**
	A substantial, five level prototype effort is planned for the chambers. It will include operational, electronics design, beam test and pre-production prototypes to validate the electronics performance and develop the fabrication procedure. Tooling for production and test equipment are included in this effort.
1.2.2.1.1.3	**Fabrication/Procurement**
	TRIUMF will produce 256 chambers. This effort includes labor and materials.
1.2.2.1.2	**Gas System**
	The dual coordinate drift chambers operate with an Argon/CF4 gas supply and re-circulating system at atmospheric pressure. This WBS describes the effort necessary to design, procure, and assemble the gas system. This WBS is a summary level. Detail description and cost estimation are completed at lower levels.
1.2.2.1.2.1	**Design**

WBS Number	Descriptio
	This effort includes the tasks necessary to design an Argon/CF4 gas supply and re-circulating system operating at atmospheric pressure for the chambers. Drawings and specifications will be developed. Fabrication procedures will be developed for in-house a
1.2.2.1.2.2	**Prototype**
1.2.2.1.2.3	**Fabrication/Procurement**
	TRIUMF will procure and assemble components for the gas system for the 256 chambers. This effort includes labor and materials, and final test of the system at TRIUMF.
1.2.2.2	**Scintillator System**
	The scintillator system consists of 288 scintillator planes and associated electronics for read out. This WBS describes
the	
	effort necessary to design, prototype, fabricate, and assemble the scintillator system. This WBS is a summary level. Detail description and cost estimation are completed at lower levels.
1.2.2.2.1	**Scintillator Plates**
	The 288 scintillator planes will be fabricated at TRIUMF. This WBS describes the effort necessary to design, prototype, fabricate, and assemble the scintillators into Preradiator Modules. This WBS is a summary level. Detail description and
cost	
	estimation are completed at lower levels.
1.2.2.2.1.1	**Design**
1.2.2.2.1.2	**Prototype**
1.2.2.2.1.3	**Fabrication/Procurement**
	TRIUMF will procure scintillators to construct 288 module elements. This effort includes labor for vendor oversight and receiving inspection, and materials for scintillator, wavelength shifting fibers and test equipment to monitor light output and uniformity which is critical to the performance of this element.
1.2.2.2.2	**WLS fiber**
1.2.2.2.2.2	**Prototype**
1.2.2.2.2.3	**Fabrication/Procurement**
1.2.2.2.3	**Scintillator readout**

WBS Number	Descriptio
	The 288 scintillator modules will be fabricated at TRIUMF. This WBS describes the effort necessary to procure and/or fabricate, and assemble the scintillator instrumentation into the scintillator system. The instrumentation system will be composed of photomultiplier tubes, and read-out electronics to read them out. This WBS is a summary level. Detail description and cost estimation are completed at lower levels.
1.2.2.2.3.1	**Photo Tube**
	The 288 scintillator plates will be fabricated at TRIUMF. This WBS describes the effort necessary to procure and/or fabricate, and assemble the scintillator instrumentation into the scintillator system. The instrumentation system will be composed of photomultiplier tubes, and read-out electronics to read them out.
1.2.2.2.3.1.3	**Fabrication/Procurement**
	TRIUMF will procure PMTs to construct 288 module elements. This effort includes labor for trade studies, bid evaluation
and	
	vendor oversight, and receiving inspection, and materials for PMTs.
1.2.2.2.3.2	**MU Metal Shield/Bases**
	The 288 scintillator modules will be fabricated at TRIUMF. This WBS describes the effort necessary to procure and/or fabricate, and assemble the scintillator instrumentation into the scintillator system. The instrumentation system will be composed of photomultiplier tubes, and read-out electronics to read them out.
1.2.2.2.3.2.3	**Fabrication/Procurement**
	TRIUMF will procure mu metal shields for the PMTs to construct 288 module elements. This effort includes labor for trade studies, bid evaluation and vendor oversight, and receiving inspection, and materials for Mu metal shields.
1.2.2.2.3.3	**Cables**
	The 288 scintillator modules will be fabricated at TRIUMF. This WBS describes the effort necessary to procure and/or fabricate, and assemble the scintillator instrumentation into the scintillator system. The instrumentation system will be composed of photomultiplier tubes, and read-out electronics to read them out.
1.2.2.2.3.3.3	**Fabrication/Procurement**
	TRIUMF will procure cables to construct 288 module elements. This effort includes labor for trade studies, bid evaluation
and	
	vendor oversight, and receiving inspection, and materials for cables.
1.2.2.2.3.4	**Preamplifier**

WBS Number	Descriptio
	Production, test & selection of 1536 PMT-preamplifiers
1.2.2.2.3.4.3	**Fabrication/Procurement**
	Production of 1536 PMT-preamplifiers
1.2.2.3	**Electronics**
1.2.2.3.1	**Anode Electronics**
1.2.2.3.1.1	**Design**
1.2.2.3.1.2	**Prototype**
1.2.2.3.1.3	**Fabrication/Procurement**
1.2.2.3.2	**Cathode Electronics**
1.2.2.3.2.1	**Design**
1.2.2.3.2.2	**Prototype**
1.2.2.3.2.3	**Fabrication/Procurement**
1.2.2.3.3	**HV, LV PSs and controllers**
1.2.2.3.3.1	**Design**
1.2.2.3.3.2	**Prototype**
1.2.2.3.3.3	**Fabrication/Procurement**
1.2.2.3.4	**DAQ interface**
1.2.2.3.4.1	**Design**
1.2.2.3.4.2	**Prototype**
1.2.2.3.4.3	**Fabrication/Procurement**
1.2.2.3.5	**Scintillator Electronics**

WBS Number	Descriptio
modules	Scintillator readout electronic has to be include 1536 channels of a 10-bit & 250 MHz WFD, 6 Crate data-collection and 6 mainframes
1.2.2.3.5.1	**WFD Boards**
WFD	WFD-board has to be including 16 channels of a 10-bit/250 MHz WFD, one “trigger” output that is providing signal if any channel exceeds over threshold, and a special fast link to a crate data-collection board.
1.2.2.3.5.1.3	**Fabrication/Procurement**
	Production of 96 WFD boards
1.2.2.3.5.1.5	**Test**
	Test of 96 WFD boards
1.2.2.3.5.2	**Crate Data-Collection Boards**
links	The crate data-collection board has to be collecting data from 16 WFD board (256 WFD channels) thru the special fast and transfer these collected data to a high level
1.2.2.3.5.2.3	**Fabrication/Procurement**
	Production of 6 Crate data-collection boards
1.2.2.3.5.2.5	**Test**
	Test of 6 Crate data-collection boards
1.2.2.3.5.3	**VXI Mainframes & Controller**
	6 VXI (or PCI) mainframe & controller for 100 WFD boards and 6 data-collection boards
1.2.2.3.5.3.3	**Fabrication/Procurement**
	6 VXI (or PCI) 20-slots mainframes with VXI (or PCI) controller
1.2.2.4	**Mechanical**

WBS Number	Descriptio
	The 32 Preradiator Modules, each consisted of nine scintillator planes and eight drift chamber planes, will be fabricated at TRIUMF. The modules will be installed at BNL on a Support Structure (1.2.2.4.2) which consists of frames and cables.
This	WBS describes the effort necessary to design, prototype, fabricate, and assemble the structure for the Preradiator Modules. This WBS is a summary level. Detail description and cost estimation are completed at lower levels.
1.2.2.4.1	**Support plates**
1.2.2.4.1.1	**Design**
1.2.2.4.1.2	**Prototype**
1.2.2.4.1.3	**Fabrication/Procurement**
1.2.2.4.2	**Support rails**
1.2.2.4.2.1	**Design**
1.2.2.4.2.2	**Prototype**
1.2.2.4.2.3	**Fabrication/Procurement**
1.2.2.4.3	**Transport/storage**
	Storage during the construction, and construction of shipping crates/boxes.
1.2.2.4.3.1	**Design**
1.2.2.4.3.2	**Prototype**
1.2.2.4.3.3	**Fabrication/Procurement**
1.2.2.5	**External Photon Veto**
	1600 PMT-instrumented modules
1.2.2.5.1	**Design**
	Design of External Photon Veto (Conceptual design & Detailed drawings)
1.2.2.5.1.1	**Conceptual Design**

WBS Number	Descriptio
	Conceptual design of External Photon Veto
1.2.2.5.1.2	**Technical Design**
	Detailed drawings of External Photon Veto
1.2.2.5.2	**Tools & Test Equipment**
	Production-tool & test-equipment production
1.2.2.5.2.1	**Cosmic Ray Setup**
	A “cosmic ray” setup for a complex test of the PMT-instrumented modules
1.2.2.5.2.2	**Molding Forms and Stamps**
	Production of molding-forms and stamps for modules
1.2.2.5.3	**Module**
	Fabrication of 1600 Photon Veto modules
1.2.2.5.3.1	**Scintillator Tiles**
	Fabrication of 500,000 Scintillator Tiles
1.2.2.5.3.1.3	**Fabrication/Procurement**
1.2.2.5.3.2	**Lead Tiles**
	Fabrication of 500,000 Lead Tiles
1.2.2.5.3.2.3	**Fabrication/Procurement**
1.2.2.5.3.3	**WLS Fiber**
	Mechanical, thermal and optical treatment of 170,000 (260 km) Wave-Length-Shifting fibers
1.2.2.5.3.3.3	**Fabrication/Procurement**
1.2.2.5.3.4	**Assembly**

WBS Number	Descriptio
	Assembling of 1600 Photon Veto modules (300 Scintillator tiles, 300 Lead tiles and 72 WLS fibers per module)
1.2.2.5.3.4.3	**Fabrication/Procurement**
1.2.2.5.3.5	**Test**
	Mechanical & optical test of the assembled Photon Veto modules
1.2.2.5.3.6	**Packing**
	Packing and warehousing of Photon Veto modules before a complex "cosmic-ray" test of PMT-instrumented modules
1.2.2.5.4	**Module Instrumentation**
	PMT instrumentation of 1600 Photon Veto modules (PMT, PMT-preamplifier, PMT HV-supply, PMT mechanics)
1.2.2.5.4.1	**PMT**
	Procurement & test of PMT, development of PMT data-base
1.2.2.5.4.1.3	**Fabrication/Procurement**
1.2.2.5.4.2	**Preamplifier**
	Production, test & selection of 1600 PMT-preamplifiers
1.2.2.5.4.2.3	**Fabrication/Procurement**
1.2.2.5.4.3	**LV-HV Converter**
	Procurement of LV-HV converters, production & test of HV-supply units, development of the HV-supply data-base
1.2.2.5.4.3.3	**Fabrication/Procurement**
1.2.2.5.4.4	**Mechanics**
	Production of the PMT mechanics: PMT-housing, mechanical support for preamplifier & HV-unit, panel for
1.2.2.5.4.4.3	**Fabrication/Procurement**
1.2.2.5.4.5	**Assembly**

WBS Number	Descriptio
	Assembling of the PMT-units: PMT, preamplifier & HV-supply unit, the connector panel, PMT housing
1.2.2.5.4.5.3	**PMT**
1.2.2.5.4.6	**Test**
	A complex test of the assembled PMT-units, development of PMT-unit data-base
1.2.2.5.4.6.3	**PMT**
1.2.2.5.4.7	**Packing**
	Packing and warehousing of PMT-units before a complex "cosmic-ray" test of PMT-instrumented modules
1.2.2.5.4.7.3	**PMT**
1.2.2.5.5	**Cosmic Ray Test of Module/PMT**
	Installation of 1600 PMT-units on Photon Veto modules, a complex "cosmic-ray" test of PMT-instrumented modules, development of data-base for PMT-instrumented Photon Veto modules
1.2.2.5.6	**Instrumentation**
	Instrumentation of External Photon Veto, including the PMT HV Control System, “Cosmic-ray” Pre-calibration System, Monitoring/Calibration System and Readout System.
1.2.2.5.6.1	**HV Control System**
	Photon Veto HV control system (1600 programmable D-A VME converters for control of PMT HV-supply units)
1.2.2.5.6.1.3	**Fabrication/Procurement**
	Procurement, test & software’s development of the HV Control System for PMTs that is including 100 IP-mezzanine-
modules	
	of the 12-bit D-A converters (XIP-5220-016, Xycom, Inc.), 25 VME-carriers for 100 IP-mezzanine-modules (XVME-9660, Xycom, Inc.) & 3 VME /VXI 13-slots mainframes with VME /VXI controller.
1.2.2.5.6.2	**Self-triggering Pre-calibration**

WBS Number	Descriptio
	Photon Veto Self-triggered Pre-calibration System is based on detection and analysis of signals from the “cosmic ray muons” that are vertically traversing Photon Veto modules. Detection of these muons will be selected by a simple trigger, formed from a coincidence between the top and bottom horizontal rows of Photon Veto modules. This system will allow to pre-calibrate 1600 Photon Veto modules with accuracy 2-3% in several hours, even from
1.2.2.5.6.2.3	**Fabrication/Procurement**
	Procurement, test & software’s development of the Self-triggered Pre-calibration System that is including 24 VME-16-channels modules of the programmable Low Threshold Discriminator (V814, CAEN), 4 VME-modules of the programmable trigger logic (V495, CAEN) and 2 VME 20-slots mainframes with VME controller (6021 series,
1.2.2.5.6.3	**Monitoring & Calibration System**
stabilization	Photon Veto monitoring-calibration system is based on the "ultrabright LED-lamps" with an electronic method of of the LED-lamp light output. This system will include 25 units. Each unit will service 64 Photon Veto modules.
1.2.2.5.6.3.1	**Design**
	Design of Photon Veto monitoring-calibration system: a LED pulse generator with optical feedback, a 64-channels optical splitter of a LED light
1.2.2.5.6.3.2	**Prototype**
	Prototyping of Photon Veto monitoring-calibration system (one 64-channels optical splitter & a LED pulse
1.2.2.5.6.3.3	**Fabrication/Procurement**
	Fabrication of Photon Veto monitoring-calibration system (44 units & a start-up NIM-logic)
1.2.2.5.6.4	**Readout Electronics**
modules	Photon Veto readout electronic has to be include 1600 channels of a 10-bit & 250 MHz WFD, 7 Crate data-collection and 7 mainframes
1.2.2.5.6.4.1	**WFD Boards**
WFD	WFD-board has to be including 16 channels of a 10-bit/250 MHz WFD, one “trigger” output that is providing signal if any channel exceeds over threshold, and a special fast link to a crate data-collection board.

WBS Number	Descriptio
1.2.2.5.6.4.1.3	**Fabrication/Procurement**
	Production of 100 WFD boards
1.2.2.5.6.4.1.5	**Test**
	Test of 100 WFD boards
1.2.2.5.6.4.2	**Crate Data-Collection Boards**
	The crate data-collection board has to be collecting data from 16 WFD board (256 WFD channels) thru the special fast links and transfer these collected data to a high level
1.2.2.5.6.4.2.3	**Fabrication/Procurement**
	Production of 7 Crate data-collection boards
1.2.2.5.6.4.2.5	**Test**
	Test of 7 Crate data-collection boards
1.2.2.5.6.4.3	**VXI Mainframes & Controller**
	7 VXI (or PCI) mainframe & controller for 100 WFD boards and 7 data-collection boards
1.2.2.5.6.4.3.3	**Fabrication/Procurement**
	7 VXI (or PCI) 20-slots mainframes with VXI (or PCI) controller
1.2.2.5.6.5	**Electronic Racks & LV Power Supplies**
	The water-cooling racks for the control/readout electronics, LV power supply for PMT preamplifiers & PMT
1.2.2.5.6.5.1	**LV Power Supplies**
	Low voltage power supply for PMT preamplifiers & PMT HV-chips, including 10 12-VDC power supplies (RM-50M) and 10 5-VDC power supplies (RM-30M) power supplies, produced by Astron corp.
1.2.2.5.6.5.1.3	**Fabrication/Procurement**
1.2.2.5.6.5.2	**Electronic Racks**

WBS Number	Descriptio
	4 water-cooling racks for the control/readout electronics
1.2.2.5.6.5.2.3	**Fabrication/Procurement**
1.2.2.6	**Pre-installation work at BNL**
1.2.2.6.1	**Design**
1.2.2.6.2	**Prototype**
1.2.2.6.3	**Fabrication/Procurement**
1.2.2.10	**Management**

WBS Number	Descriptio
1.2.4	**Charged Particle Veto**
1.2.4.1	**Barrel Charged PV**
1.2.4.1.1	**Overall Design**
1.2.4.1.1.1	**Design**
	Complete system and it's integration in vacuum tank
1.2.4.1.2	**Scintillator Count Mods.**
	(Bare scintillator plates)
1.2.4.1.2.2	**Prototype**
	Testing of additional prototypes, geometry and scintillator type
1.2.4.1.2.3	**Fabrication/Procurement**
	Cutting, milling and polishing (coating?)
1.2.4.1.3	**Detector Modules**
	(Light tight modules with PMT and integration in support structure)
1.2.4.1.3.1	**Design**
1.2.4.1.3.2	**Prototype**
	Coating vs. wrapping, PMT vs. Geigermode APD
1.2.4.1.3.3	**Fabrication/Procurement**
	300 detector modules
1.2.4.1.3.4	**PMT assembly**
	Type, quality selection
1.2.4.1.4	**Detector Support Structure**

WBS Number	Descriptio
	(Fixation of detector modules to vacuum tank)
1.2.4.1.4.2	**Prototype**
	Choice of material and check of mechanical stability
1.2.4.1.4.3	**Fabrication/Procurement**
1.2.4.1.5	**Detector Module Assembly**
	(Installation of the detector modules into the support structure)
1.2.4.1.5.3	**Fabrication/Procurement**
1.2.4.1.6	**Calibration System**
	(Injection of defined light pulse into each detector module)
1.2.4.1.6.2	**Prototype**
	Check signal amplitude and stability (Common solution for all KOPIO scintillators?)
1.2.4.1.6.3	**Fabrication/Procurement**
1.2.4.1.7	**Vacuum System Integration**
	(Separation from beam vacuum, feedthroughs through tank)
1.2.4.1.7.1	**Design**
1.2.4.1.7.1.1	**Overall Design**
1.2.4.1.7.1.2	**Vacuum Flange Design**
	Flanges contain all feedthroughs
1.2.4.1.7.2	**Prototype**
	Selection of types
1.2.4.1.7.3	**Fabrication/Procurement**

WBS Number	Descriptio
1.2.4.1.8	**Assembly of complete Detector**
1.2.4.1.9	**Detector Test**
	(Check functionality in light tight container)
1.2.4.1.9.1	**Laboratory Test**
	Test with sources and/or cosmic rays
1.2.4.1.9.2	**Beam Test**
	Tests at PSI
1.2.4.1.10	**Shipping**
	From Zürich to Brookhaven
1.2.4.1.11	**Installation at BNL**
1.2.4.2	**Downstream Charged PV**
1.2.4.2.1	**Overall Design**
1.2.4.2.1.1	**Design**
1.2.4.2.2	**Scintillator Count Mods.**
1.2.4.2.2.1	**Design**
1.2.4.2.2.2	**Prototype**
1.2.4.2.2.3	**Fabrication/Procurement**
1.2.4.2.3	**Detector Modules**
1.2.4.2.3.1	**Design**
1.2.4.2.3.2	**Prototype**
1.2.4.2.3.3	**Fabrication/Procurement**

WBS Number	Descriptio
1.2.4.2.3.4	PMT assembly
1.2.4.2.3.5	Testing
1.2.4.2.4	Detector Support Structure
1.2.4.2.4.2	Prototype
1.2.4.2.4.3	Fabrication/Procurement
1.2.4.2.5	Detector Module Assembly
1.2.4.2.5.3	Fabrication/Procurement
1.2.4.2.6	Calibration System
1.2.4.2.6.2	Prototype
1.2.4.2.6.3	Fabrication/Procurement
1.2.4.2.6.4	Assembly/Test
1.2.4.2.7	Vacuum System Integration
1.2.4.2.7.1	Design
1.2.4.2.7.1.1	Overall Design
1.2.4.2.7.1.2	Vacuum Flange Design
1.2.4.2.7.2	Prototype
1.2.4.2.7.3	Fabrication/Procurement
1.2.4.2.8	Assembly of complete Detector
1.2.4.2.9	Detector Test
1.2.4.2.9.1	Laboratory Test
1.2.4.2.9.2	Beam Test

WBS Number	Descriptio
1.2.4.2.10	**Shipping**
1.2.4.2.11	**Installation at BNL**
1.2.4.3	**On Detector Electronics**
	(All electronic components inside vacuum)
1.2.4.3.1	**Prototype**
1.2.4.3.2	**Fabrication/Procurement**
1.2.4.4	**Off Detector Electronics**
	(All electronic components outside vacuum)
1.2.4.4.1	**Cabling**
	Selection of cable type and lengths
1.2.4.4.2	**Low Voltage Supplies**
	Common for all KOPIO?
1.2.4.4.3	**HV Supplies**
	Common for all KOPIO?
1.2.4.4.4	**Splitters/connectors**
1.2.4.4.5	**W.f.d./discriminator**
	Common for all KOPIO?

WBS Number	Descriptio
1.2.5	**Photon Veto**
1.2.5.1	**Upstream Photon Veto**
	Upstream Photon Veto detectors placed just before the vacuum vessel which surrounds the decay volume. It consists of 186 sandwich modules readout from 2 ends with WLS fibers and phototubes.
1.2.5.1.1	**Log Module**
	Log module is a sandwich assembled of 15 lead-scintillator layers. WLS fibers are glued in the scintillator slabs.
1.2.5.1.1.1	**WLS Fibers**
	Multi-clad Y11 wave-length shifting(WLS) fibers manufactured by Kuraray
1.2.5.1.1.1.1	**Design**
	Design of fiber readout, optimization of spacing
1.2.5.1.1.1.3	**Fabrication/Procurement**
	Production of 210 km of Y11 fibers, selection of fiber cuts, stress tests
1.2.5.1.1.2	**Scintillator**
	Extruded polystyrene based plastic with fluorescent dopants
1.2.5.1.1.2.1	**Design**
	Optimization of technological modes
1.2.5.1.1.2.3	**Fabrication/Procurement**
	Extrusion of 2800 scintillator slabs, mechanical trimming in size
1.2.5.1.1.3	**Reflective Covering/Gluing**
	Covering of the scintillator with chemical reflector, gluing of fibers into the scintillator slabs
1.2.5.1.1.3.1	**Design**
1.2.5.1.1.3.3	**Fabrication/Procurement**

WBS Number	Descriptio
	Covering of the scintillator slabs with chemical reflector, gluing of fibers into the scintillator slabs
1.2.5.1.1.4	**Lead**
	Lead sheets of 1 mm thickness
1.2.5.1.1.4.1	**Design**
1.2.5.1.1.4.3	**Fabrication/Procurement**
	Rolling the lead to the calibrated thickness, cutting of the 2800 lead sheets to the required size
1.2.5.1.1.5	**Assembly & Test**
	Assembling the sandwich modules from layers of lead and scintillator slabs and test of light output.
1.2.5.1.1.5.3	**Fabrication/Procurement**
	Assembling the 186 sandwich modules from layers of lead and scintillator slabs. Optical treatment the fiber readout
ends.	
	Optical isolation of logs. Mounting the phototubes housings. Test of light output of assembled modules.
1.2.5.1.1.6	**Shipping**
	Packing and shipping the logs from the manufacturer to the BNL
1.2.5.1.1.6.1	**Fabrication/Procurement**
	Packing and shipping the logs from the manufacturer to the BNL
1.2.5.1.2	**UpstreamVeto Assembling**
	Assembling the Upstream Veto wall from the logs. Connecting the readout instrumentation. Cosmic tests and calibration
of	
	the detector.
1.2.5.1.2.5	**Installation/Test**
	Assembling the Upstream Veto wall from the logs. Connecting the readout instrumentation. Cosmic tests and calibration
of	
	the detector.
1.2.5.1.3	**Instrumentation**
	Photoreadout of the WLS fibers.

WBS Number	Descriptio
1.2.5.1.3.1	**Tube Base+Divider**
	HV divider circuit assembly for photomultipliers (380 pcs)
1.2.5.1.3.1.3	**Fabrication/Procurement**
	Fabrication of HV divider circuits
1.2.5.1.3.2	**Photo Tube**
	Photomultiplier tubes with green-extended photocathodes
1.2.5.1.3.2.3	**Fabrication/Procurement**
	Fabrication of 380 photomultiplier tubes with green-extended photocathode
1.2.5.1.3.3	**MU Shield+Assembling parts**
	Magnetic shields from m-metal, connectors, mechanical parts for the phototube housings
1.2.5.1.3.3.3	**Fabrication/Procurement**
	Fabrication of 380 magnetic shields from m-metal, connectors, mechanical parts for the phototube housing
1.2.5.1.3.4	**LV-HV converter**
	Compact hybrid converter of low voltage supply in high voltage for the phototubes
1.2.5.1.3.4.3	**Fabrication/Procurement/Test**
	Fabrication of 380 LV-HV converters and their tests before mounting
1.2.5.1.3.5	**Cables (2 signal + 2 LV)**
	Signal coaxial cables (2 per channel) with connectors, cable for low voltage supply (12V), low voltage shielded cable for HV control
1.2.5.1.3.5.3	**Fabrication/Procurement**
	Production of cables for 186 readout channels
1.2.5.1.3.5.4	**Installation/Support**

WBS Number	Descriptio
	Installation of 750 cables.
1.2.5.1.4	**Calibration & Monitoring**
	Optical system to monitor the detector performance and stability
1.2.5.1.4.1	**Fiber Optics**
	Optical cables to deliver the light from the reference source to the phototubes
1.2.5.1.4.1.1	**Design**
	Design of the optical cabling, optical splitters
1.2.5.1.4.1.2	**Assembling**
	Routing and connection of optical cables, mounting of hardware parts
1.2.5.1.4.1.3	**Fabrication/Procurement/Test**
	Fabrication, preparation and optical treatment of the optical cables and fan-out mixers
1.2.5.1.4.2	**Electronics**
	Front-end electronic units to process the reference signals
1.2.5.1.4.3	**Light Source**
	The source of the reference light
1.2.5.1.4.3.1	**Design**
	Design of the LED based reference light source
1.2.5.1.4.3.3	**Fabrication/Procurement**
	Fabrication of the light source and its adjustment
1.2.5.1.4.4	**Reference PMT**
	The photomultiplier tubes to monitor the stability of the reference light source

WBS Number	Descriptio
1.2.5.1.4.4.1	**Design**
1.2.5.1.4.4.3	**Fabrication/Procurement**
	Production of 2 reference phototubes and their tests
1.2.5.1.4.5	**Hardware**
	Mechanical parts for support and routing the fiber optic and light source
1.2.5.1.4.5.3	**Fabrication/Procurement**
	Fabrication of mechanical parts for support and routing the fiber optic and light source
1.2.5.1.5	**Mechanics**
	Mechanical frame to support the sandwich logs and provide easy moving the Upstream Veto detector out of the setup
1.2.5.1.5.1	**Design**
	Design of the support mechanics and service tools
1.2.5.1.5.3	**Fabrication/Procurement**
	Production of mechanical parts and service tools
1.2.5.1.5.4	**Assembling**
	Mounting the support frame and adjustment to the place.
1.2.5.1.5.6	**Shipping**
	Packing and shipping the mechanical frame from the manufacturer to the BNL
1.2.5.1.6	**Front-end Electronics**
	Electronics to process signals from the phototubes, mounted outside the Upstream Veto detector
1.2.5.1.6.1	**Wave Form Digitizers**
	WFD-board has to be including 16 channels of a 10-bit/250 MHz waveform digitizers

WBS Number	Descriptio
1.2.5.1.6.1.1	**Design**
	Design of WFD
1.2.5.1.6.1.3	**Fabrication/Procurement**
	Production of 25 WFD boards and 2 crates for boards
1.2.5.1.6.1.4	**Assembling/Test**
	Test and adjustments of 400 WFD channels
1.2.5.1.6.2	**HV Control System**
	System to set and adjust high voltage supply for phototubes with low-voltage levels
1.2.5.1.6.2.1	**Design**
	Design of HV control system
1.2.5.1.6.2.3	**Fabrication/Procurement**
	Production of 400 channels of low-voltage outputs controlled by computer, production of power modules to supply 12 V
for	LV-HV converters
1.2.5.1.6.2.4	**Assembling/Test**
	Test and adjustments of 400 low-voltage channels to control HV supply
1.2.5.2	**Barrel Photon Veto**
	Barrel Photon Veto detector surrounds the vacuum vessel and decay volume. It is assembled of 1100 sandwich modules
of	shashlyk type in the cylindrical shape.
1.2.5.2.1	**Shashlyk Module**
	Shashlyk module is a sandwich assembly of 190 layers of lead-scintillator. Light readout is implemented with WLS fibers running across layers. Shape of module is a truncated pyramid.
1.2.5.2.1.1	**WLS Fibers**
	Wave-length shifting multi-clad Y11 fibers of 1 mm diameter produced by Kuraray

WBS Number	Descriptio
1.2.5.2.1.1.1	**Design**
	Design of fiber readout, optimization of spacing
1.2.5.2.1.1.3	**Fabrication/Procurement**
	Production of 570 km of Y11 fibers, selection of fiber cuts, stress tests, thermal and optical treatment
1.2.5.2.1.2	**Scintillator**
	Molded polystyrene based plastic with fluorescent dopants
1.2.5.2.1.2.1	**Design**
1.2.5.2.1.2.3	**Fabrication/Procurement**
	Fabrication of 209,000 scintillator plates of 1.5 mm thickness , permanent monitoring of the quality of molded plates
1.2.5.2.1.3.1	**Design**
1.2.5.2.1.3.3	**Fabrication/Procurement**
	Production of Tyvek paper sheets
1.2.5.2.1.4	**Lead Sheet**
	Lead plates of 0.5 mm thickness
1.2.5.2.1.4.1	**Design**
1.2.5.2.1.4.3	**Fabrication/Procurement**
	Rolling the lead to the calibrated 0.5 mm thickness, cutting and punching of the 209,000 lead plates
1.2.5.2.1.5	**Assembly & Test**
	Assembling the shashlyk modules from lead and scintillator plates. Machining of module sides to make a truncated
pyramid	
	shape. Optical treatment the fiber readout ends. Optical isolation of modules. Mounting the phototubes housing. Test of
light	
	output of assembled modules.
1.2.5.2.1.5.1	**Fabrication/Procurement**

WBS Number	Descriptio
	Assembling the 1100 shashlyk modules from lead and scintillator plates and reflector paper. Machining of module sides to make a truncated pyramid shape. Optical treatment the fiber readout ends. Optical isolation of modules. Mounting the phototubes housing. Test of light output of assembled modules.
1.2.5.2.1.6	**Shipping**
	Packing and shipping the modules from the manufacturer to the BNL
1.2.5.2.1.6.1	**Fabrication/Procurement**
	Packing and shipping the modules from the manufacturer to the BNL
1.2.5.2.2	**Barrel Veto Assembling**
	Assembling the Barrel Veto from the shashlyk modules. Connecting the readout instrumentation. Cosmic tests and calibration of the detector.
1.2.5.2.2.5	**Installation/Test**
	Assembling the Barrel Veto from the shashlyk modules. Connecting the readout instrumentation. Cosmic tests and calibration of the detector.
1.2.5.2.3	**Instrumentation**
	Photoreadout of the WLS fibers.
1.2.5.2.3.1	**Tube Base+Divider**
	HV divider circuit assembly for photomultipliers (1100 pcs)
1.2.5.2.3.1.3	**Fabrication/Procurement**
	Fabrication of HV divider circuits
1.2.5.2.3.2	**Photo Tube**
	Photomultiplier tubes with green-extended photocathodes
1.2.5.2.3.2.3	**Fabrication/Procurement/Test**
	Fabrication of 1100 photomultiplier tubes with green-extended photocathode

WBS Number	Descriptio
1.2.5.2.3.3	**MU Shield+Assembling parts**
	Magnetic shields from m-metal, connectors, mechanical parts for the phototube housings
1.2.5.2.3.3.3	**Fabrication/Procurement/Assembling**
	Fabrication of 1100 magnetic shields from m-metal, connectors, mechanical parts for the phototube housing
1.2.5.2.3.4	**LV-HV converter**
	Compact hybrid converter of low voltage supply in high voltage for the phototubes
1.2.5.2.3.4.3	**Fabrication/Procurement/Test**
	Fabrication of 380 LV-HV converters and their tests before mounting
1.2.5.2.3.5	**Cables (2 signal +2 LV)**
	Signal coaxial cables (2 per channel) with connectors, cable for low voltage supply (12V), low voltage shielded cable for HV control
1.2.5.2.3.5.3	**Fabrication/Procurement**
	Production of cables for 1100 readout channels
1.2.5.2.3.5.4	**Installation/Support**
	Installation of 4400 cables.
1.2.5.2.4	**Calibration & Monitoring**
	Optical system to monitor the detector performance and stability
1.2.5.2.4.1	**Fiber Optics**
	Optical cables to deliver the light from the reference source to the phototubes
1.2.5.2.4.1.1	**Design**
	Design of the optical cabling, optical splitters
1.2.5.2.4.1.3	**Fabrication/Procurement**

WBS Number	Descriptio
	Fabrication, preparation and optical treatment of the optical cables and fan-out mixers
1.2.5.2.4.1.4	**Assembling/Test**
	Routing and connection of optical cables, mounting of hardware parts
1.2.5.2.4.2	**Electronics**
	Front-end electronic units to process the reference signals
1.2.5.2.4.2.1	**Light Source+ReadOut modules**
	The source of the reference light
1.2.5.2.4.2.1.1	**Design**
	Design of the LED based reference light source
1.2.5.2.4.2.1.3	**Fabrication/Procurement/Test**
	Fabrication of the light source and its adjustment
1.2.5.2.4.2.2	**Reference PMT**
	The photomultiplier tubes to monitor the stability of the reference light source
1.2.5.2.4.2.2.1	**Design**
1.2.5.2.4.2.2.3	**Fabrication/Procurement**
	Production of 2 reference phototubes and their tests
1.2.5.2.4.3	**Hardware**
	Mechanical parts for support and routing the fiber optic and light source
1.2.5.2.4.3.3	**Fabrication/Procurement**
	Fabrication of mechanical parts for support and routing the fiber optic and light source
1.2.5.2.5	**Mechanics**

WBS Number	Descriptio
	Mechanical frame to support the shashlyk modules, provide easy opening to get access to the vacuum vessel
1.2.5.2.5.1	**Design**
	Design of the support mechanics and service tools
1.2.5.2.5.3	**Fabrication/Procurement**
	Production of mechanical parts and service tools
1.2.5.2.5.4	**Assembling**
	Mounting the support frame and adjustment to the place.
1.2.5.2.5.6	**Shipping**
	Packing and shipping the mechanical frame from the manufacturer to the BNL
1.2.5.2.6	**Front-end Electronics**
	Electronics to process signals from the phototubes, mounted outside the Barrel Veto detector
1.2.5.2.6.1	**Wave Form Digitizers**
	WFD-board has to be including 16 channels of a 10-bit/250 MHz WFD
1.2.5.2.6.1.1	**Fabrication/Procurement**
	Production of 70 WFD boards and 5 crates for boards
1.2.5.2.6.1.4	**Assembling/Test**
	Test and adjustments of 1100 WFD channels
1.2.5.2.6.2	**HV Control System**
	System to set and adjust high voltage supply for phototubes with low-voltage levels
1.2.5.2.6.2.1	**Design**
	Design of HV control system

WBS Number	Descriptio
1.2.5.2.6.2.3	**Fabrication/Procurement** Production of 1100 channels of low-voltage outputs controlled by computer, production of power modules to supply 12 V for LV-HV converters
1.2.5.2.6.2.4	**Assembling/Test** Test and adjustments of 1100 low-voltage channels to control HV supply

WBS Number	Descriptio
1.2.6	**Catcher**
1.2.6.1	**Aerogel Counter**
	A photon counter to veto gamma-rays coming along the neutral K beam. It consists of 370 identical modules placed in an array.
1.2.6.1.1	**Modules**
	One module is composed of a lead plate, aerogel tiles, a light-reflecting mirror, a light-collecting funnel and a 5-inch PMT.
1.2.6.1.1.1	**Aerogel Tile**
	Aerogel of the refractive index 1.03-1.05 to produce Cerenkov light upon the passage of electrons.
1.2.6.1.1.1.3	**Fabrication/Procurement**
	Procurement of 1665 liters of aerogel.
1.2.6.1.1.2	**Lead Plate**
	Lead plate to convert gamma-rays to electrons and positrons.
1.2.6.1.1.2.3	**Fabrication/Procurement**
	Procurement of 370 2-mm-thick lead plates.
1.2.6.1.1.3	**PMT - 5 inch**
	PMT to detect Cerenkov lights produced by aerogel tiles.
1.2.6.1.1.3.3	**Fabrication/Procurement**
	Procurement of 370 5-inch PMTs.
1.2.6.1.1.4	**Mirrors**
	Mirror to reflect Cerenkov lights into PMTs.
1.2.6.1.1.4.3	**Fabrication/Procurement**
	Fabrication of 370 mirrors with one side coated with aluminum by vacuum deposition.

WBS Number	Descriptio
1.2.6.1.1.5	**Funnels**
	Funnel placed in front of the PMT to collect lights otherwise going outside the PMT cathode.
1.2.6.1.1.5.3	**Fabrication/Procurement**
	Fabrication of 370 funnels with inner side coated with aluminum by vacuum deposition.
1.2.6.1.2	**Support Frames**
	Support frame to place aerogel counter modules.
1.2.6.1.2.3	**Fabrication/Procurement**
	Fabrication of a set of support frames for 370 aerogel counter modules.
1.2.6.2	**Guard Counter**
	A photon counter to veto gamma-rays coming to the periphery of the main neutral beam. It surrounds the aerogel counter and consists of 144 identical modules.
1.2.6.2.1	**Modules**
	One module is composed of 8 layers of lead plates, 8 layers of acrylic slabs and a 5-inch PMT.
1.2.6.2.1.1	**Acrylic Sheet**
	Transparent acrylic slab to produce Cerenkov light upon the passage of electrons.
1.2.6.2.1.1.3	**Fabrication/Procurement**
	Procurement of 1152 acrylic slabs.
1.2.6.2.1.2	**Lead Plate**
	Lead plate to convert gamma-rays to electrons and positrons.
1.2.6.2.1.2.3	**Fabrication/Procurement**
	Procurement of 1152 2-mm-thick lead plates.
1.2.6.2.1.3	**PMT - 5 inch**

WBS Number	Descriptio
	PMT to detect Cerenkov lights produced by aerogel tiles.
1.2.6.2.1.3.3	**Fabrication/Procurement**
	Procurement of 144 5-inch PMTs.
1.2.6.2.2	**Support Frames**
	Support frame to place guard counter modules.
1.2.6.2.2.3	**Fabrication/Procurement**
	Fabrication of a set of support frames for 144 guard counter modules.
1.2.6.3	**Readout Electronics**
	System of reading and recording PMT signals.
1.2.6.3.1	**HV Power Supply**
	Power supply to provide all PMTs with HV power.
1.2.6.3.1.3	**Fabrication/Procurement**
	Procurement of 514 (370+144) channels of the HV power supply.
1.2.6.3.2	**Waveform Digitizer**
	Waveform digitizer to digitize and record PMT signals.
1.2.6.3.2.3	**Fabrication/Procurement**
	Fabrication of 514 channels of the waveform digitizer.
1.2.6.3.3	**ADC's**
	ADC to digitize and record PMT signal charges.
1.2.6.3.3.3	**Fabrication/Procurement**
	Fabrication of 514 channels of the ADC.

WBS Number	Descriptio
1.2.6.3.4	**TDC's**
	TDC to digitize and record PMT signal timings.
1.2.6.3.4.3	**Fabrication/Procurement**
	Fabrication of 514 channels of the TDC.
1.2.6.3.5	**Cables**
	HV power and signal cables for all PMTs.
1.2.6.3.5.3	**Fabrication/Procurement**
	Procurement of 514 channels of the HV and signal cables.
1.2.6.4	**Monitoring System**
	Monitoring system to calibrate and monitor both aerogel and guard counters consisting of LEDs and associated electronics.
1.2.6.4.3	**Fabrication/Procurement**
	Fabrication of the monitoring system, composed of 2 temperature boxes, 6 optical fiber bundles, and 6 reference photomultipliers.
1.2.6.5	**Commissioning**
	Commissioning of the catcher, including the aerogel counter, guard counter and the monitoring system. It is carried out in steps including turn-on power tests, tests with the LED lights provided by the monitoring system, tests with the actual beam and calibration runs.

WBS Number	Descriptio
1.2.7	**Trigger**
1.2.7.1	**Definition of the architecture**
	Define the Trigger elements and their interconnection. Requires simulation work and a study of the requirements in commection with the F.E.E. development.
1.2.7.1.1	**MC simulations**
1.2.7.1.2	**Analysis of F.E.E. performance**
1.2.7.1.3	**Specifications of trigger elements**
1.2.7.1.4	**Define interconnection protocols**
1.2.7.2	**Interconnection boards**
	VME boards that implement the protocol of communication between different stages of the Trigger and include memories
to	
	feed the output and memories to read the inputs. These boards are developed as prototypes of the interconnection
protocol.	
1.2.7.2.2	**Prototype development and test**
1.2.7.2.3	**Fabricate boards for test benches**
1.2.7.3	**Trigger digitizers: PR,CAL, veto**
	25MHZ ADC/TDC modules dedicated for the Trigger. They provide 10 bit pulse height information and 1ns time
information for	
	PM signals. Basic module is a 24 input module coming in two different flavors which differ for the digital signal
processing.	
1.2.7.3.1	**TDC prototype development and test**
1.2.7.3.2	**ADC prototype development and test**
1.2.7.3.3	**ASIC for analog preprocessing**
1.2.7.3.4	**Development of FPGA firmware for flavor A**
1.2.7.3.5	**Development of FPGA firmware for flavor B**

WBS Number	Descriptio
1.2.7.3.6	**Development and test of full board**
1.2.7.3.7	**Standalone bench test**
1.2.7.3.8	**Preproduction**
1.2.7.3.9	**ASIC production**
1.2.7.3.10	**Production**
1.2.7.3.11	**Installation and cabling**
1.2.7.4	**Module collector**
	Each section of this board collects time/pulse height data from two serial inputs carrying data from 12 counters each, applies a programmable threshold to each signal and to their sum, producing suitable coded logical signals…
1.2.7.4.1	**Design and review**
1.2.7.4.2	**Prototype development and test**
1.2.7.4.3	**Development and test of full board**
1.2.7.4.4	**Production**
1.2.7.4.5	**Installation and cabling**
1.2.7.5	**Strip routing cards**
	These cards receive data from PR and calorimeter digitizers through a special crate backplane and rearrange them in groups of corresponding strips. Assuming that each module can handle 12 strips there would be 1 such module in a digitizer crate
1.2.7.5.1	**Design and review**
1.2.7.5.2	**Develop digitizer crate backplane**
1.2.7.5.3	**Routing card prototype development and test**
1.2.7.5.4	**Development and test of full board**

WBS Number	Descriptio
1.2.7.5.5	**Production**
1.2.7.5.6	**Fabricate and mount custom backplane**
1.2.7.6	**Strip collector**
and	This board perform sums of back to back strips in adjacent quardrants, applies thresholds to the individual "long" strips
boards	performs sums in depth of the pulse height information of 9 modules. Each module receives input from 2 strip routing
1.2.7.6.1	**Design and review**
1.2.7.6.2	**Prototype development and test**
1.2.7.6.3	**Development and test of full board**
1.2.7.6.4	**Production**
1.2.7.6.5	**Installation and cabling**
1.2.7.7	**Digitizers-collectors system test**
	Set up a system including digitizers, strip transition boards, module collectors and strip collectors and exercise it with random pulses of variable rate. The system allows to read out each module separately in order to check the data
1.2.7.7.1	**Set up hardware for test**
1.2.7.7.2	**Develop online software for test**
1.2.7.7.3	**Perform test and analyze data**
1.2.7.8	**Projection card**
	Finds clusters in projection integrated in depth. Receives input from 2 strip collectors for each view. There is one board for the x view and one board for the y view.
1.2.7.8.1	**Design and review**
1.2.7.8.2	**Generation of test data**
1.2.7.8.3	**Prototype development and test**

WBS Number	Descriptio
1.2.7.8.4	**Construction**
1.2.7.9	**Pattern recognition card**
	Receives digital signals from the strip collector of one view of the PR-CAL and applies pattern recognition algorithm
1.2.7.9.1	**Design and review**
1.2.7.9.2	**Generation of test data**
1.2.7.9.3	**Prototype development and test**
1.2.7.9.4	**Construction**
1.2.7.10	**Boolean logic card**
	Receives inputs in the form of zero suppressed time information on several channels and performs logic combination of them with time windows programmable for each input
1.2.7.10.1	**Design and review**
1.2.7.10.2	**Generation of test data**
1.2.7.10.3	**Prototype development and test**
1.2.7.10.4	**Construction**
1.2.7.11	**Installation and cabling of the LV1 logic crate**
	Connection of the logic cards in the detector area and installation of the cables between the detectors and the central
logic.	
	Cable centric logic.
1.2.7.12	**Supervision and monitoring system**
	This system combines information from different sources to produce parallel Triggers individually selectable and
prescalable.	
	It also distributes the Trigger information to the front end modules and handles busy signals from them.
1.2.7.12.1	**System design**
1.2.7.12.2	**Alignment board development and test**

WBS Number	Descriptio
1.2.7.12.3	**Trigger formation board developmnet and test**
1.2.7.12.4	**Trigger transmitter development and test**
1.2.7.12.5	**Scalers**
1.2.7.12.6	**Fabrication**
1.2.7.12.7	**Installation and cabling**
1.2.7.13	**Clock system**
information	Generation and distribution of a 25MHz clock synchronized to the extraction RF and capable of encoding Trigger and other control information.
1.2.7.13.1	**Master clock**
1.2.7.13.1.1	**Design and review**
1.2.7.13.1.2	**Prototype and test**
1.2.7.13.1.3	**Fabricate and test**
1.2.7.13.2	**Clock drivers**
1.2.7.13.2.1	**Design and review**
1.2.7.13.2.2	**Prototype and test**
1.2.7.13.2.3	**Fabricate and test**
1.2.7.13.3	**Clock receivers**
1.2.7.13.3.1	**Design and review**
1.2.7.13.3.2	**Prototype and test**
1.2.7.13.3.3	**Fabricate and test**
1.2.7.13.4	**Assemble, test, install system**
1.2.7.14	**Infrastructure**

WBS Number	Descriptio
	This item includes hardware common to several subsystems, general services for the Trigger and tasks that can be grouped for budget and resource optimization
1.2.7.14.1	**Crates**
1.2.7.14.2	**Crate interfaces (PCI?)**
1.2.7.14.3	**Cables**
1.2.7.14.4	**Readout controllers**
1.2.7.14.5	**Control CPU's**
1.2.7.15	**Commissioning**
1.2.7.15.1	**Develop trigger control programs**
1.2.7.15.2	**Develop trigger readout programs**
1.2.7.15.3	**Test logic chain with simulated data**
1.2.7.15.4	**Test logic chain + supervisor with simulated data**
1.2.7.15.5	**Test digitizers with cosmic rays or beam data**
1.2.7.15.6	**Test full chain**
1.2.7.16	**LV3 event selection software**
1.2.7.17	**Milestones and reviews**
1.2.7.17.1	**Finalize trigger options**
1.2.7.17.2	**Digitizers PDR**
1.2.7.17.3	**Collector modules PDR**
1.2.7.17.4	**Logic modules PDR**
1.2.7.17.5	**Trigger supervisor PDR**
1.2.7.17.6	**Clock system PDR**

WBS Number	Descriptio
1.2.7.17.7	Digitizers PRR
1.2.7.17.8	Collector modules PRR
1.2.7.17.9	Logic modules PRR
1.2.7.17.10	Trigger supervisor PRR
1.2.7.17.11	Clock system PRR

WBS Number	Descriptio
1.2.8	**DAQ**
1.2.8.1	**Event Builder**
of	The event builder builds complete events from event fragments sent by the front-end electronics. It is based on a cluster PC's communicating through a network switch.
1.2.8.1.1	**Event Builder System Development**
1.2.8.1.1.1	**Software development**
	Procurement of test cluster for DAQ development: 4 PC's with PCI Express internal bus, dual 3 GHz Xeon, Infiniband-4x HCA, 8-port Infiniband-4x switch, 4 Infiniband-4x cables.
1.2.8.1.1.2	**Installation of XDAQ tools**
	Installation of XDAQ software tools on test cluster.
1.2.8.1.1.3	**Simple data transfer tests**
	Simple tests of data transfer speed through Infiniband network
1.2.8.1.1.4	**Tests in XDAQ framework**
	Simple EB system running in XDAQ Implementation of a 2input-2output event builder on the test cluster, using the XDAQ toolset
1.2.8.1.1.5	**Measurement of data transfer speed**
builder	Measurements of data transfer speed through event builder, comparisons with ethernet, identification of bottlenecks Preparation involves development of software for front-end readout, run control, event logger, integration with event and level 3 t
1.2.8.1.2	**Event builder beam test**
1.2.8.1.2.1	**Preparation for beam test**
	My assumption here is that we will have a beam test of preradiator and calorimeter systems at around
1.2.8.1.2.2	**Beam test**

WBS Number	Descriptio
	Test beam run of combined preradiator-calorimeter system
1.2.8.1.3	**Design modification and review**
	Develop needed design modifications based on experience of beam test. Culminates in preliminary design review of the event builder system on 4/30/07.
1.2.8.1.4	**EB procurement (25%)**
	Procurement of 25% of the hardware needed for the event builder 1. 20 PC's. Unit PC cost based on Dell PowerEdge
2850	
	with dual 10-GHz Xeon, 4GB RAM, 4x-Infiniband HCA. Dual-port gigabit ethernet card. 2. 32-port 4x-Infiniband switch 3.
20	
	Infiniband ca
1.2.8.1.5	**Final design test**
	Tests with the "25%" event builder and L3 trigger. Monte Carlo events for input, passed through event builder and L3
trigger	
	systems. Performance checks of the hardware. Culminates in final design review on 4/30/08.
1.2.8.1.6	**EB procurement (75%)**
	Procurement of remaining event builder hardware: 1. 60 PC's 2. 100-port Infiniband switch 3. 60 Infiniband cables
1.2.8.1.7	**Integration**
	Installation of event builder, integration with front-end electronics, integration with L1/L3 trigger, run control
1.2.8.2	**Level 3 trigger**
	The level 3 trigger operates on complete events output by the event builder. The trigger selects those events that are thought to be most interesting for sending to mass torage and later physics analysis. The L3 trigger may also perform detector calibra
1.2.8.2.1	**Level 3 trigger System Development**
1.2.8.2.1.1	**Algorithm development**
	Monte Carlo simulation of trigger algorithms. Develop coherent picture of all trigger levels and data rates.
1.2.8.2.2	**Software performance tests**
1.2.8.2.2.1	**Running in XDAQ**

WBS Number	Descriptio
	Implementation of simple level 3 trigger in XDAQ framework.
1.2.8.2.2.2	**Speed measurements**
	Measurement of CPU time performance of level 3 trigger algorithms. Refinement of algorithms as needed.
1.2.8.2.3	**Beam test**
1.2.8.2.3.1	**Preparation for beam test**
builder	Preparation involves development of software for front-end readout, run control, event logger, integration with event and level 3 trigger
1.2.8.2.3.2	**Beam test**
	Test beam run of combined preradiator-calorimeter system
1.2.8.2.4	**Design modification and review**
	Develop needed design modifications based on experience of beam test. Culminates in preliminary design review of the level 3 trigger on 4/30/07.
1.2.8.2.5	**Trigger procurement (25%)**
	Procurement of 25% of the hardware needed for the level 3 trigger. 1. 100 PC's. Unit PC cost estimated at monarchcomputer.com 10-GHz Xeon, single processor. 2GB RAM. 2 dual-port gigabit ethernet cards.
1.2.8.2.6	**Final design test**
trigger	Tests with the "25%" event builder and L3 trigger.Monte Carlo events for input, passed through event builder and L3 systems. Performance checks of the hardware. Culminates in final design review on 4/30/08.
1.2.8.2.7	**Trigger procurement (75%)**
	Procurement of remaining level 3 trigger and event logger hardware. 1. 300 PC's, 2. disk array
1.2.8.2.8	**Integration**
	Installation of L3 trigger, integration with L1 trigger, run control, event logger, event builder
1.2.8.2.9	**Administration**

WBS Number	Descriptio
	Life of experiment. 1/2 time computer/network system administrator to take care of routine maintenance of event builder, level 3 trigger, network hardware
1.2.8.3	**Hardware co-processor**
	The speed of the level 3 trigger may be increased significantly by building dedicated hardware to perform parts of the
trigger	
	calculations. This may be needed if commercially available PC's are not powerful enough to provide the level 3 trigger rejection
1.2.8.3.1	**Preliminary design**
	Exploration of co-processor architectures, communication with host CPU, RAM, interface to PCI Express
1.2.8.3.2	**Prototype**
	Implementation of trigger algorithm into silicon. Iterations with prototypes. Culminates in preliminary design review.
1.2.8.3.3	**Final design**
	Prototype of final design. Tests with Monte Carlo events. Culminates in final design review.
1.2.8.3.4	**Final design review**
1.2.8.3.5	**Fabrication/production**
	Production/testing of probably several hundred co-processor boards
1.2.8.3.6	**Installation and integration**
1.2.8.4	**Online software**
	The online software is the glue that holds the DAQ system together. It includes a run controller, a user interface, event logger, interfaces to the event builder, to the L1/L3 triggers, to the slow control, and to online monitoring/calibration tasks.
1.2.8.4.1	**Online software System Development**
1.2.8.4.1.1	**Simple online system running in XDAQ framework**
1.2.8.4.2	**Beam test**
1.2.8.4.2.1	**Preparation for beam test**

WBS Number	Descriptio
	Preparation involves development of software for front-end readout, run control, event logger, integration with event builder and level 3 trigger
1.2.8.4.2.2	**Beam test**
	Test beam run of combined preradiator-calorimeter system
1.2.8.4.3	**Design modification and review**
	Refine design of the online system based on the performance in the beam test. Culminates in preliminary design review on 4/30/07.
1.2.8.4.4	**Prototype and test**
	Tests with the "25%" event builder and L3 trigger. Monte Carlo events for input, passed through event builder and L3 trigger systems. Culminates in final design review on 4/30/08.
1.2.8.4.5	**Final design review**
1.2.8.4.6	**Integration**
	Integration with L1/L3 trigger, run control, event logger, event builder, front-end electronics, slow control

WBS Number	Descriptio
1.2.9	**Off-line Computing** U.S. ATLAS Maintenance and Operations (M&O) includes detector specific costs allocated to subsystems and Common Fund cost related to overall experimental operations.
1.2.9.1	**Off-line Computing Hardware**
1.2.9.1.1	**Processors (200* 2CPU)**
1.2.9.1.2	**Workstations (15* $1k)**
1.2.9.1.3	**Disks and Peripherals**
1.2.9.1.4	**Switches**
1.2.9.1.5	**Racks, Infrastructure**
1.2.9.1.6	**System Support (yearly x 5 yr)**
1.2.9.1.7	**Integration**
1.2.9.2	**Off-line Computing Software**
1.2.9.2.1	**Simulations**
1.2.9.2.2	**Event Reconstruction**
1.2.9.2.3	**Analysis**
1.2.9.2.4	**Tools**
1.2.9.2.5	**Integration**
1.2.9.2.6	**Workshops**
1.2.9.3	**Analysis**
1.2.9.3.1	**Calibrations**
1.2.9.3.2	**Physics**
1.2.9.4	**Software integration**

WBS Number	Descriptio
1.2.9.4.3	Data Management System
1.2.9.4.4	Event Generators
1.2.9.4.5	Analysis Shell
1.2.9.4.6	Integration
1.2.9.5	Tools
1.2.9.5.1	Analysis framework
1.2.9.5.2	Data format
1.2.9.5.3	Data management system
1.2.9.5.4	Calibration databases
1.2.9.5.5	Detector description language
1.2.9.5.6	Grid based production system

WBS Number	Descriptio
1.2.10	**KOPIO Project Detector Systems**
	The KOPIO Detector, large in size and scope, offers as a project many technical challenges in subsystem design, fabrication, installation, testing and commissioning. The overall detector design, utility requirements, installation, testing
and	
	commissioning efforts requires managerial control and oversight to assist individual subsystems in their construction
efforts.	
	These efforts also include KOPIO Project interface and interaction with the Collider-Accelerator (C-A) project personnel to insure that beam transport and detector meet the physics operational goals as specified in the baseline. The elements of
this	
	subsystem establish the KOPIO project management controls for detector integration, installation, conventional systems, testing and commissioning. It includes the cost and schedule of all materials and labor required to accomplish this effort.
1.2.10.1	**Integration**
	Detector integration consists of the following elements: Subsystem dimension control, Detector subsystem utilities routing, Assembly and service scenario modeling, Integration management activities.
1.2.10.1.1	**Subsystem Dimensional Control**
	Engineering and design effort is being devoted to ensure that subsystems fit together, can be assembled and serviced,
and	
	have minimal negative impact on other subsystems performance. Subsystem overall integration dimensional boundaries
will	
	be defined along with assembly clearances. It is important to note that these integration dimensional boundaries represent simple geometrical volumes and maximum subsystem dimensional limits. Subsystems nominal dimensions will likely be different due to manufacturing and alignment tolerances and will fall within these integration volumes. More detailed geometries will be defined as subsystems evolve. CAD solid modeling will be used to defined these geometries in an unambiguous manner.
1.2.10.1.1.1	**Conceptual Layout**
1.2.10.1.1.2	**Conceptual Design Review**
1.2.10.1.1.3	**Design**
1.2.10.1.2	**Subsystem Utilities Routing**

WBS Number	Descriptio
	Cable and pipe routing, provisions for electronics power and cooling and ventilation needs are being developed within conventional systems. Many of these conventional system utilities provide detector subsystems with AC power, HVAC, cooling water, specialty gases, and safety interlocks. CAD solid modeling of these utility paths will be used to visualize, define and check for interferences of this routing throughout the experimental area. A general concept will be developed for the routing of these conventional systems utility services from their source on the experimental floor to the various subsystem detector components, electronics racks, and detector control room.
1.2.10.1.2.1	**Conceptual Layout**
1.2.10.1.2.2	**Conceptual Design Review**
1.2.10.1.2.3	**Design**
1.2.10.1.3	**Assembly & Services Modeling**
	Initial assembly and subsequent servicing of the detector will be modeled in both 2-D and 3-D CAD in order to determine the dimensions for the experimental area and detector floor pit to insure adequate fit and access on the existing C-A experimental floor. The KOPIO Detector will be assembled, fully connected to utilities, and tested on the experimental floor. The figure below shows the assembled detector in the neutral beam line after the primary beam "B" target station.Once the Switchyard, Primary beam, and Neutral beam line construction is completed along with the experimental floor pit, assembly of the various detector subsystem components can begin based on an approved installation plan. Integration will assist in providing the necessary effort to determine the optimum detector assembly scenario based on beam line construction, subsystem component delivery and staging, and experimental floor space constraints.Integration will also assist in developing detector subsystem component service scenarios. The type of service depends on the component failure, loss of physics coverage, scope of effort and time to repair. A major service scenario may require the detector to be down for more than a day with removal of shielding and the removal and replacement of subsystem components with operable spares. This will require procedures detailing the sequential rigging or removal of adjoining components to access defective components. A minor service scenario would be for quick access, less than a shift, to trouble shoot operational problems or component failures and respond to Detector Safety Interlock alarms. The majority of these minor services issues would be for replacement of electronics components or crate failures. The third type of service would take place during long term C-A shutdowns, monthly time periods, in which many of the subsystems could be disassembled for maintenance and systems

upgrades.

1.2.10.1.3.1 **Conceptual Layout**

1.2.10.1.3.2 **Conceptual Design Review**

1.2.10.1.3.3 **Design**

WBS Number	Descriptio
1.2.10.1.4	**Management Activities**
	This element includes the cost for the overall coordination and management of the day-to-day and long term integration activities. Included is the cost of an onsite integration manager, engineering, design drafting, administrative/clerical support, and materials/supplies.
1.2.10.1.4.1	**Pre-construction Effort**
1.2.10.1.4.2	**Manager**
1.2.10.1.4.3	**Engineering**
1.2.10.1.4.4	**Administration**
1.2.10.1.4.5	**Procurement**
1.2.10.1.4.5.1	**MSTS FY06**
1.2.10.1.4.5.2	**MSTS FY07**
1.2.10.1.4.5.3	**MSTS FY08**
1.2.10.1.4.5.4	**MSTS FY09**
1.2.10.1.4.5.5	**MSTS FY10**
1.2.10.1.4.5.6	**Computer Hardware/Software FY06**
1.2.10.1.4.5.7	**Computer Hardware/Software FY07**
1.2.10.1.4.5.8	**Computer Hardware/Software FY08**
1.2.10.1.4.5.9	**Computer Hardware/Software FY09**
1.2.10.1.4.5.10	**Computer Hardware/Software FY10**
1.2.10.2	**Detector Installation**
	This includes the cost and schedule of all labor required to install the baseline KOPIO Detector in the Collider-Accelerator (C-A) experimental floor, Bldg. 912. Installation consists of the following elements: Subsystem Installation, Installation Equipment, Management Activities

WBS Number	Descriptio
1.2.10.2.1	**Subsystem Installation**
	Once a subsystem component of the KOPIO Detector is delivered to the C-A experimental floor at BNL, the expense of further assembly and installation is budgeted for in this element unless otherwise negotiated with the Project Manager.
This	element includes all labor costs associated with the assembly and installation of all detector subsystems once they have been delivered to the C-A experimental facilities at BNL. This also includes any miscellaneous expense and travel items incurred during these activities. Cost for continuation of engineering and technical support of a detector subsystem by the home institution is not covered by this element. This element does not include the cost of planning the installation of
individual	detector subsystems. This means planning for installation of individual subsystems is included in subsystem WBS and overall installation planning is included in Integration. Subsystem installation includes the following subsystems:
1.2.10.2.1.1	**Vacuum**
1.2.10.2.1.1.1	**Start U/S Decay Vessel Assembly**
1.2.10.2.1.1.2	**Deliver U/S Decay Vessel**
1.2.10.2.1.1.3	**Uncrate and Stage**
1.2.10.2.1.1.4	**Install Internal CPV Supports**
1.2.10.2.1.1.5	**Clean and Pre-Assemble**
1.2.10.2.1.1.6	**Install Feed-throughs in Adapter Flanges**
1.2.10.2.1.1.7	**Vessel Pressure Testing**
1.2.10.2.1.1.8	**Disassemble Vessel**
1.2.10.2.1.1.9	**Install U/S Vacuum Pipe and End Dome**
1.2.10.2.1.1.10	**Install Vessel Supports in Photon Veto**
1.2.10.2.1.1.11	**Install Cylindrical Vessel in Photon Veto**
1.2.10.2.1.1.12	**Install D/S Vacuum Pipe and End Dome**
1.2.10.2.1.1.13	**Install Internal CPV Modules**

WBS Number	Descriptio
1.2.10.2.1.1.14	Install HV Membrane and Windows
1.2.10.2.1.1.15	Close U/S Decay Vessel
1.2.10.2.1.1.16	Rout Fiber and Cable
1.2.10.2.1.1.17	U/S Decay Vessel Assembly Complete
1.2.10.2.1.1.18	Start D/S Vessel Assembly
1.2.10.2.1.1.19	Deliver Support Structure
1.2.10.2.1.1.20	Establish Reference Datums
1.2.10.2.1.1.21	Install Floor Anchors
1.2.10.2.1.1.22	Install Floor Plates
1.2.10.2.1.1.23	Level Floor Plates
1.2.10.2.1.1.24	Install Grout Frames
1.2.10.2.1.1.25	Grout Floor Plates
1.2.10.2.1.1.26	Deliver D/S Vessel
1.2.10.2.1.1.27	Uncrate and Stage
1.2.10.2.1.1.28	Install Veto Detector Supports
1.2.10.2.1.1.29	Clean and Assemble
1.2.10.2.1.1.30	Install Feed-throughs and Flanges
1.2.10.2.1.1.31	Vessel Pressure Testing
1.2.10.2.1.1.32	Rout Fiber and Cable
1.2.10.2.1.1.33	D/S Vessel Assembly Complete
1.2.10.2.1.1.34	Start Vacuum Pumping Station Assembly

WBS Number	Descriptio
1.2.10.2.1.1.35	Deliver Pumping Skid
1.2.10.2.1.1.36	Pour Concrete Pad
1.2.10.2.1.1.37	Install Floor Anchors
1.2.10.2.1.1.38	Install Skid on Pad
1.2.10.2.1.1.39	Hook-up AC Power
1.2.10.2.1.1.40	Connect Vacuum System
1.2.10.2.1.1.41	System Testing
1.2.10.2.1.1.42	Vacuum Pump Station Assembly Complete
1.2.10.2.1.2	Preradiator
1.2.10.2.1.2.1	Start Mechanical Assembly
1.2.10.2.1.2.2	Deliver Support Structure
1.2.10.2.1.2.3	Establish Reference Datums
1.2.10.2.1.2.4	Install Floor Anchors
1.2.10.2.1.2.5	Install Floor Plates
1.2.10.2.1.2.6	Level Floor Plates
1.2.10.2.1.2.7	Install Grout Frames
1.2.10.2.1.2.8	Grout Floor Plates
1.2.10.2.1.2.9	Assemble Support Structure
1.2.10.2.1.2.10	Deliver Module Support Fixtures
1.2.10.2.1.2.11	Assemble Module Support Fixtures
1.2.10.2.1.2.12	Deliver Modules

WBS Number	Descriptio
1.2.10.2.1.2.13	Stage Modules on Fixtures
1.2.10.2.1.2.14	Pre-Testing of Modules
1.2.10.2.1.2.15	Install Modules in Support Structure
1.2.10.2.1.2.16	Deliver Gas System
1.2.10.2.1.2.17	Install Gas System
1.2.10.2.1.2.18	Deliver Chilled Water System
1.2.10.2.1.2.19	Install Chilled Water System
1.2.10.2.1.2.20	Install Hydraulic Drives
1.2.10.2.1.2.21	Roll Into Operating Position
1.2.10.2.1.2.22	Mechanical Assembly Complete
1.2.10.2.1.2.23	Start Electrical Assembly
1.2.10.2.1.2.24	Deliver Crates and Cables
1.2.10.2.1.2.25	Install Crates in Racks
1.2.10.2.1.2.26	Install Subsystem Cable Tray
1.2.10.2.1.2.27	Install Cable Bundles
1.2.10.2.1.2.28	Subsystem Testing
1.2.10.2.1.2.28.1	Engineering
1.2.10.2.1.2.28.2	Technical
1.2.10.2.1.2.29	Electrical Assembly Complete
1.2.10.2.1.3	Calorimeter
1.2.10.2.1.3.1	Start Mechanical Assembly

WBS Number	Descriptio
1.2.10.2.1.3.2	Deliver Support Structure
1.2.10.2.1.3.3	Establish Reference Datums
1.2.10.2.1.3.4	Install Floor Anchors
1.2.10.2.1.3.5	Install Floor Plates
1.2.10.2.1.3.6	Level Floor Plates
1.2.10.2.1.3.7	Install Grout Frames
1.2.10.2.1.3.8	Grout Floor Plates
1.2.10.2.1.3.9	Assemble Support Structure
1.2.10.2.1.3.10	Deliver Shashlyk Modules
1.2.10.2.1.3.11	Install Lower Half Modules
1.2.10.2.1.3.12	Install D/S Vacuum Pipe and End Dome
1.2.10.2.1.3.13	Install Upper Half Modules
1.2.10.2.1.3.14	Install Hydraulic Drives
1.2.10.2.1.3.15	Roll Into Operating Position
1.2.10.2.1.3.16	Mechanical Assembly Complete
1.2.10.2.1.3.17	Start Electrical Assembly
1.2.10.2.1.3.18	Deliver Crates and Cables
1.2.10.2.1.3.19	Install Crates in Racks
1.2.10.2.1.3.20	Install Subsystem Cable Tray
1.2.10.2.1.3.21	Install Cable Bundles
1.2.10.2.1.3.22	Subsystem Testing

WBS Number	Descriptio
1.2.10.2.1.3.22.1	Engineering
1.2.10.2.1.3.22.2	Technical
1.2.10.2.1.3.23	Electrical Assembly Complete
1.2.10.2.1.4	Charged Particle Veto
1.2.10.2.1.4.1	Deliver CPV Supports
1.2.10.2.1.4.2	Install Internal CPV Supports
1.2.10.2.1.4.3	Deliver CPV Modules
1.2.10.2.1.4.4	Install CPV Modules in Vessel
1.2.10.2.1.4.5	Fiber and Cable Connections
1.2.10.2.1.4.6	Close U/S Decay Vessel
1.2.10.2.1.4.7	System testing
1.2.10.2.1.4.8	CPV Installed
1.2.10.2.1.5	Photon Veto
1.2.10.2.1.5.1	Start Mechanical Assembly
1.2.10.2.1.5.2	Deliver Support Structure
1.2.10.2.1.5.3	Establish Reference Datums
1.2.10.2.1.5.4	Install Floor Anchors
1.2.10.2.1.5.5	Install Floor Plates
1.2.10.2.1.5.6	Level Floor Plates
1.2.10.2.1.5.7	Install Grout Frames
1.2.10.2.1.5.8	Grout Floor Plates

WBS Number	Descriptio
1.2.10.2.1.5.9	Install U/S Wall Support Structure
1.2.10.2.1.5.10	Deliver U/S Wall Modules
1.2.10.2.1.5.11	Install Lower Half U/S Wall Modules
1.2.10.2.1.5.12	Install U/S Vacuum Pipe and End Dome
1.2.10.2.1.5.13	Install Upper Half U/S Wall Modules
1.2.10.2.1.5.14	Install Cylindrical Support Structure
1.2.10.2.1.5.15	Deliver Cylindrical Modules
1.2.10.2.1.5.16	Install Lower Half Cylindrical Modules
1.2.10.2.1.5.17	Install Vacuum Decay Tank Supports
1.2.10.2.1.5.18	Install Upper Half Cylindrical Modules
1.2.10.2.1.5.19	Mechanical Ass'y. Complete
1.2.10.2.1.5.20	Start Electrical Assembly
1.2.10.2.1.5.21	Deliver Crates and Cables
1.2.10.2.1.5.22	Install Crates in Racks
1.2.10.2.1.5.23	Install Subsystem Cable Tray
1.2.10.2.1.5.24	Install Cable Bundles
1.2.10.2.1.5.25	Subsystem Testing
1.2.10.2.1.5.25.1	Engineering
1.2.10.2.1.5.25.2	Technical
1.2.10.2.1.5.26	Electrical Assembly Complete
1.2.10.2.1.6	Catcher

WBS Number	Descriptio
1.2.10.2.1.6.1	Start Catcher Assembly
1.2.10.2.1.6.2	Deliver Support Structure
1.2.10.2.1.6.3	Establish Reference Datums
1.2.10.2.1.6.4	Install Floor Anchors
1.2.10.2.1.6.5	Install Floor Plates
1.2.10.2.1.6.6	Level Floor Plates
1.2.10.2.1.6.7	Install Grout Frames
1.2.10.2.1.6.8	Grout Floor Plates
1.2.10.2.1.6.9	Install Support Structure
1.2.10.2.1.6.10	Install Detector Modules
1.2.10.2.1.6.11	Deliver Crates and Cables
1.2.10.2.1.6.12	Install Crates in Racks
1.2.10.2.1.6.13	Install Cable Bundles
1.2.10.2.1.6.14	Subsystem Testing
1.2.10.2.1.6.14.1	Engineering
1.2.10.2.1.6.14.2	Technical
1.2.10.2.1.6.15	Catcher Assembly Complete
1.2.10.2.1.7	Conventional Systems
1.2.10.2.1.7.1	Mechanical Utilities
1.2.10.2.1.7.1.1	Chilled Water Systems
1.2.10.2.1.7.1.1.1	Staging

WBS Number	Descriptio
1.2.10.2.1.7.1.1.2	Installation & Distribution
1.2.10.2.1.7.1.1.3	Piping
1.2.10.2.1.7.1.1.4	Electrical
1.2.10.2.1.7.1.2	Conditioned Air Systems
1.2.10.2.1.7.1.2.1	Staging
1.2.10.2.1.7.1.2.2	Install Enclosure
1.2.10.2.1.7.1.2.3	Ducting & Piping
1.2.10.2.1.7.1.2.4	Electrical
1.2.10.2.1.7.1.3	Compressed Air Systems
1.2.10.2.1.7.1.3.1	Staging
1.2.10.2.1.7.1.3.2	Installation
1.2.10.2.1.7.1.3.3	Electrical
1.2.10.2.1.7.2	Electrical Utilities
1.2.10.2.1.7.2.1	Commercial Power Distribution
1.2.10.2.1.7.2.1.1	Staging
1.2.10.2.1.7.2.1.2	Installation
1.2.10.2.1.7.2.2	Clean Power Distribution
1.2.10.2.1.7.2.2.1	Staging
1.2.10.2.1.7.2.2.2	Installation
1.2.10.2.1.7.2.3	UPS Distribution
1.2.10.2.1.7.2.3.1	Staging

WBS Number	Descriptio
1.2.10.2.1.7.2.3.2	Electrical Installation
1.2.10.2.1.7.2.4	Emergency Power Distribution
1.2.10.2.1.7.2.4.1	Installation
1.2.10.2.1.7.2.5	Grounding
1.2.10.2.1.7.2.5.1	Mechanical Installation
1.2.10.2.1.7.2.5.2	Electrical Installation
1.2.10.2.1.7.2.6	Cable Distribution Systems
1.2.10.2.1.7.2.6.1	Staging
1.2.10.2.1.7.2.6.2	Tray Installation
1.2.10.2.1.7.2.6.3	Electrical Installation
1.2.10.2.1.7.2.6.4	Power Connection
1.2.10.2.1.7.3	Safety Systems
1.2.10.2.1.7.3.1	Global Interlocks and Alarm Systems
1.2.10.2.1.7.3.1.1	Mechanical Installation
1.2.10.2.1.7.3.1.2	Electrical Installation
1.2.10.2.1.7.3.1.3	Programming
1.2.10.2.1.7.3.2	Water Leak Detection Systems
1.2.10.2.1.7.3.2.1	Mechanical Installation
1.2.10.2.1.7.3.2.2	Electrical Installation
1.2.10.2.1.7.3.3	Smoke and Heat Detection Systems
1.2.10.2.1.7.3.3.1	Electrical Installation

WBS Number	Descriptio
1.2.10.2.1.7.3.4	**Flammable Gas Detection Systems**
1.2.10.2.1.7.3.4.1	**Mechanical Installation**
1.2.10.2.1.7.3.4.2	**Electrical Installation**
1.2.10.2.1.7.3.5	**Emergency Shutdown Systems**
1.2.10.2.1.7.3.5.2	**Electrical Installation**
1.2.10.2.1.7.3.6	**Fire Suppression Systems**
1.2.10.2.1.7.3.6.1	**Mechanical Installation**
1.2.10.2.1.7.3.6.2	**Electrical Installation**
1.2.10.2.1.7.3.7	**ODH Detection Systems**
1.2.10.2.1.7.3.7.1	**Mechanical Installation**
1.2.10.2.1.7.3.7.2	**Electrical Installation**
1.2.10.2.1.7.4	**Personnel Access Systems**
1.2.10.2.1.7.4.1	**Scaffolding Systems**
1.2.10.2.1.7.4.1.1	**Erect Scaffolding**
1.2.10.2.1.7.4.2	**Stairs and Walkways**
1.2.10.2.1.7.4.2.1	**Mechanical Installation**
1.2.10.2.2	**Installation Equipment**

This element includes the cost of specifying, designing, fabricating, procuring, or leasing commonly used equipment associated with installation of the KOPIO Detector. This includes hardware such as man-lifts, fork-lifts, spreader bars, standard rigging gear, hand tools, standard electronics equipment (meters, o-scopes), vehicles, and storage trailers. This does not include the cost of special installation fixtures or test equipment associated with an individual detector subsystem.

1.2.10.2.2.1	**Conceptual Planning**

WBS Number	Descriptio
1.2.10.2.2.2	**Conceptual Design Review**
1.2.10.2.2.3	**Procurement**
1.2.10.2.2.3.1	**Equipment Rental FY07**
1.2.10.2.2.3.2	**Equipment Rental FY08**
1.2.10.2.2.3.3	**Equipment Rental FY09**
1.2.10.2.2.3.4	**Equipment Rental FY10**
1.2.10.2.2.3.5	**MSTS FY06**
1.2.10.2.2.3.6	**MSTS FY07**
1.2.10.2.2.3.7	**MSTS FY08**
1.2.10.2.2.3.8	**MSTS FY09**
1.2.10.2.2.3.9	**MSTS FY10**
1.2.10.2.2.3.10	**Misc. Fabrication FY06**
1.2.10.2.2.3.11	**Misc. Fabrication FY07**
1.2.10.2.2.3.12	**Misc. Fabrication FY08**
1.2.10.2.2.3.13	**Misc. Fabrication FY09**
1.2.10.2.2.3.14	**Misc. Fabrication FY10**
1.2.10.2.3	**Management Activities**
	This element includes the cost for the overall coordination and management of the day-to-day and long term installation activities. Included is the cost of an onsite installation manager, technical supervisor, design drafting, and clerical support.
1.2.10.2.3.1	**Pre-construction Effort**
1.2.10.2.3.2	**Manager**

WBS Number	Descriptio
1.2.10.2.3.3	**Engineering**
1.2.10.2.3.4	**Technical Supervisor**
1.2.10.2.3.5	**Administration**
1.2.10.2.3.6	**Procurement**
1.2.10.2.3.6.1	**MSTS FY06**
1.2.10.2.3.6.2	**MSTS FY07**
1.2.10.2.3.6.3	**MSTS FY08**
1.2.10.2.3.6.4	**MSTS FY09**
1.2.10.2.3.6.5	**MSTS FY10**
1.2.10.2.3.6.6	**Computer Hardware/Software FY06**
1.2.10.2.3.6.7	**Computer Hardware/Software FY07**
1.2.10.2.3.6.8	**Computer Hardware/Software FY08**
1.2.10.2.3.6.9	**Computer Hardware/Software FY09**
1.2.10.2.3.6.10	**Computer Hardware/Software FY10**
1.2.10.3	**Conventional Systems**
	The scope of this element accounts for all utility requirements for the KOPIO Detector that are common to more than one subsystem. Conventional systems requirements are derived from the specific subsystem's needs and general detector integration requirements. The source of these utilities comes from the C-A department, which is only responsible for bring general AC power, cooling water, and compressed air to common interface taps near the detector. This element does not include the shielding, detector pit, conventional structures (fast electronics house, control room, counting house, gas pad, gas mixing room), facility lighting, facility fire detection and suppression, and facility overhead crane which are C-A's responsibilities. This includes the cost and schedule of all labor required for design and procurement of materials. Conventional systems consist of the following elements:Mechanical utilities, Electrical utilities, Safety systems, Personnel access systems,Management activities.

WBS Number	Descriptio
1.2.10.3.1	**Mechanical Utilities**
	These utilities systems consist of the following elements:Chilled water system- this system provides cooling water to maintain operational temperature specification of subsystem electronics. The scope of effort will be to determine and specify common electronics cooling requirements and provide the necessary closed loop chilled water pumping skid in a heat exchange with C-A SCM water systems. To distribute this cooling water as required to the various detector subsystems such as electronics racks, calorimeter PMT's and APD's, and on-board electronics crates. This will include
the	
	cost for specification, design, procurement, fabrication, and delivery of all system hardware, piping distribution and controls.Conditioned air system and enclosure- air circulation in and around the detector is not designed to remove any
heat	
	load, but to maintain a uniform temperature and low humidity condition. With the majority of the detector heat load
removed by	
	chilled water it is necessary to maintain a low enough ambient air dew point to prevent condensation from forming in and around electronics components and detector surfaces. This will include the cost for specification, design, procurement, fabrication, and delivery of all system hardware, ducting distribution, controls, and enclosure.Compressed air systems- if required for experimental use for pneumatic controls, flammable gas detectors, or the use of vortec instrument coolers.
This	
	would include the cost for specification, design, procurement, fabrication, and delivery of all system hardware such as compressor, air dryer, filtration, controls and distribution.
1.2.10.3.1.1	**Chilled Water Systems**
1.2.10.3.1.1.1	**Concept Specification**
1.2.10.3.1.1.2	**Conceptual Design Review**
1.2.10.3.1.1.3	**Engineering**
1.2.10.3.1.1.4	**Design**
1.2.10.3.1.1.5	**Procurement**
1.2.10.3.1.1.6	**Fabrication**
1.2.10.3.1.2	**Conditioned Air Systems & Enclosure**
1.2.10.3.1.2.1	**Concept Specification**
1.2.10.3.1.2.2	**Conceptual Design Review**
1.2.10.3.1.2.3	**Engineering**
1.2.10.3.1.2.4	**Design**

WBS Number	Descriptio
1.2.10.3.1.2.5	Procurement
1.2.10.3.1.2.6	Fabrication
1.2.10.3.1.3	Compressed Air Systems
1.2.10.3.1.3.1	Concept Specification
1.2.10.3.1.3.2	Conceptual Design Review
1.2.10.3.1.3.3	Engineering
1.2.10.3.1.3.4	Design
1.2.10.3.1.3.5	Procurement
1.2.10.3.1.3.6	Fabrication
1.2.10.3.2	Electrical Utilities

WBS Number	Descriptio
1.2.10	These utility systems consist of the following elements:Commercial power distribution- this is the continuation and distribution of C-A facility power (dirty power) through the experimental area as required. It represents the nominal 110/208/480-vac power required to power mechanical and rotary equipment and tools used in the installation, maintenance, and operation of the detector. This would include the cost for specification, design, procurement, and delivery of all system hardware such as breaker panels, conduit, cable and receptacles.Clean power distribution- this is experimental power derived from commercial power through isolation transformers on a common single point detector electrical ground. This is done so that machinery or other rotary equipment used upstream of the isolation transformer, does not induce electrical noise into detector electronics. The majority of this power will be used to power experimental subsystem electronics, electrical crates, LV/HV power supplies, electrical racks and control room computer systems all on a common ground. This would include the cost for specification, design, procurement, and delivery of all system hardware such as isolation transformers, breaker panels, conduit, cable and receptacles.Uninterrupted power systems- this power is derived from clean power and provides temporary back-up for critical operational experimental systems. These are usually rack mountable battery systems (UPS) that provide 20-30 minute power during commercial power dips. They will be required for critical systems that monitor safety interlocks and detectors, flammable gas systems controls, and control room computers. This would include the cost of specification, procurement, and delivery of all system hardware.Emergency power distribution-this power is derived from diesel generator back-up systems at C-A. It will be needed for experimental emergency lighting, cooling systems for temperature critical components, flammable gas systems, and critical vacuum systems. This would include the cost of specification, procurement, and delivery of all system hardware for distribution at the experiment.Detector electrical grounding- because there are many low voltage and low current signals used in the detector subsystems, it is necessary to insure that we operate in a low electrical noise environment. Consequently, proper precautions must be taken when planning the grounding of the detector in conjunction with clean electrical power distribution and ground fault monitoring, to eliminate ground loops and reduce electrical noise. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Electronics rack systems- these racks are used to house the majority of experimental electronics instrumentation, crates and power supplies needed in support of detector subsystems. The majority of these racks will be housed either in the Fast Electronics House or the control room and will sit atop elevated computer flooring to allow for orderly distribution of cable bundles to and from the racks. These are 19-inch standard rack widths, which will contain AC clean power distribution and breaker panels, smoke and heat detection, chilled water distribution and heat exchangers, fan blowers and filter units. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Cable distribution systems- this is a system of wire ways, cable trays, conduits, and festoon systems required to distribute AC power, LV/HV power,

signal, and fiber optic cable bundles throughout the detector, its subsystems, Fast Electronics House and control room. Specially configured cable trolleys and flexible tray systems maybe required to maintain electrical interconnectivity while subsystem components are maneuvered for maintenance and access needs. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.

WBS Number	Descriptio
1.2.10.3.2.1	Commercial Power Distribution
1.2.10.3.2.1.1	Concept Specification
1.2.10.3.2.1.2	Conceptual Design Review
1.2.10.3.2.1.3	Engineering
1.2.10.3.2.1.4	Design
1.2.10.3.2.1.5	Procurement
1.2.10.3.2.2	Clean Power Distribution
1.2.10.3.2.2.1	Concept Specification
1.2.10.3.2.2.2	Conceptual Design Review
1.2.10.3.2.2.3	Engineering
1.2.10.3.2.2.4	Design
1.2.10.3.2.2.5	Procurement
1.2.10.3.2.3	Uninterrupted Power Systems
1.2.10.3.2.3.1	Concept Specification
1.2.10.3.2.3.2	Conceptual Design Review
1.2.10.3.2.3.3	Engineering
1.2.10.3.2.3.4	Design
1.2.10.3.2.3.5	Procurement
1.2.10.3.2.4	Emergency Power Distribution
1.2.10.3.2.4.1	Concept Specification
1.2.10.3.2.4.2	Conceptual Design Review

WBS Number	Descriptio
1.2.10.3.2.4.3	Engineering
1.2.10.3.2.4.4	Design
1.2.10.3.2.4.5	Procurement
1.2.10.3.2.5	Detector Electrical Ground
1.2.10.3.2.5.1	Concept Specification
1.2.10.3.2.5.2	Conceptual Design Review
1.2.10.3.2.5.3	Engineering
1.2.10.3.2.5.4	Design
1.2.10.3.2.5.5	Procurement
1.2.10.3.2.5.6	Fabrication
1.2.10.3.2.6	Electronics Rack Systems
1.2.10.3.2.6.1	Concept Specification
1.2.10.3.2.6.2	Conceptual Design Review
1.2.10.3.2.6.3	Engineering
1.2.10.3.2.6.4	Design
1.2.10.3.2.6.5	Procurement
1.2.10.3.2.6.6	Fabrication
1.2.10.3.2.7	Cable Distribution Systems
1.2.10.3.2.7.1	Concept Specification
1.2.10.3.2.7.2	Conceptual Design Review
1.2.10.3.2.7.3	Engineering

WBS Number	Descriptio
1.2.10.3.2.7.4	Design
1.2.10.3.2.7.5	Procurement
1.2.10.3.2.7.6	Fabrication
1.2.10.3.3	Safety Systems

WBS Number	Descriptio	1.2.10

These utilities systems consist of the following elements:Global interlocks and alarm systems- this is a system designed to allow the KOPIO detector and its subsystems to operate safely; it provides protection against major equipment damage, particularly that due to the effects of fire and water leakage. Typically, each subsystem will have its own local interlock system that will detect and react to hazards localized to the particular component (over current or over temperature, for example). These local interlock systems are used to guide the power-up and power-down procedures, and are not within the scope of this element. The global interlocks and alarm system is mainly concerned with major hazards from common utilities (conventional systems) failures, and contains interlock and alarm elements for water leak detection, smoke and

heat

detection, flammable gas detection, and emergency off system. The system must satisfy the requirements of the detector electrical grounding plan. This system will be implemented using industry standard programmable logic controllers (PLCs) based on relay logic code. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment. System operation, maintenance, and certification will be the responsibility of C-A department.Water leak detection systems- this is a system used to automatically sense water leaks, usually at hose

fittings

and connections, from the distributed chilled water system throughout the detector and interrupt flow, with automatic valves, to that circuit in order to minimize damage to critical electronics. It would be integrated into the Global interlocks

and

alarm system and is required for equipment protection. A similar system, within C-A scope, to detect sweeper magnet

water

leaks may need to be integrated into the same interlocks and alarm system. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Smoke and heat detection systems- this is a fire detection system of high sensitivity smoke and heat detectors located inside electronics rack bays and in close

proximity

to operational detector electronics. The system of detectors along with programmable fire alarm panels would fall within

the

scope of the BNL Fire Systems Group for life safety requirements with direct alarm notification to the BNL fire station. It would also be integrated into the Global interlocks and alarm system for equipment protection. Detection of smoke would latch an interlock and alarm and automatically trip electrical power to subsystems and electronics in the detection area.

Heat

detection would automatically trip electrical power and engage fire suppression systems if required. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Flammable gas

detection

systems- this is a system used to sniff and detect combustible levels of flammable gas leaking from experimental gas distribution systems into the environment. It will require multiplexing from numerous detection sites and calibration

capability.

It would be integrated into the Global interlocks and alarm system and is required for equipment protection. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Emergency shutdown systems- this is a system intended for the emergency use of authorized and trained personnel who detect hazardous conditions, for equipment protection, that require immediate action. These will be clearly labeled and manually operated emergency off buttons located at strategic locations in the experimental area; experimental area access gate,

fast

electronics house, control room, and experimental pit. These emergency off buttons are interlocked to the experiment AC power distribution system and via shunt-trips will force circuit breakers to open, positively removing electrical hazards. The loss of experimental AC power will require all subsystems to fail to a safe state which will require the purge of all

flammable

gases. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment. System maintenance and certification will be the responsibility of C-A department.Fire suppression systems-this is a system that maybe required based on DOE/BNL guidelines of equipment loss value. These are automated

systems

that are engaged from heat detectors located in electronics racks. A typical system will flood a rack compartment with an inert gas to reduce oxygen levels and extinguish any fire once the source of power is removed. This fire suppression

WBS Number	Descriptio
system	system would fall within the scope of the BNL Fire Systems Group for life safety requirements with direct alarm notification to the BNL fire station. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.ODH detection systems- this is an oxygen-deficiency-hazard system of detectors and monitors used in the experimental pit area and experimental gas mixing areas to alert personnel of the hazard. This would fall within the scope of the C-A Personnel Access and Security Systems (PASS) Group for life safety requirements. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.
1.2.10.3.3.1	**Global Interlocks and Alarm Systems**
1.2.10.3.3.1.1	**Concept Specification**
1.2.10.3.3.1.2	**Conceptual Design Review**
1.2.10.3.3.1.3	**Engineering**
1.2.10.3.3.1.4	**Design**
1.2.10.3.3.1.5	**Procurement**
1.2.10.3.3.1.6	**Fabrication**
1.2.10.3.3.2	**Water Leak Detection Systems**
1.2.10.3.3.2.1	**Concept Specification**
1.2.10.3.3.2.2	**Conceptual Design Review**
1.2.10.3.3.2.3	**Engineering**
1.2.10.3.3.2.4	**Design**
1.2.10.3.3.2.5	**Procurement**
1.2.10.3.3.2.6	**Fabrication**
1.2.10.3.3.3	**Smoke and Heat Detection Systems**

WBS Number	Descriptio
1.2.10.3.3.3.1	Concept Specification
1.2.10.3.3.3.2	Conceptual Design Review
1.2.10.3.3.3.3	Engineering
1.2.10.3.3.3.4	Design
1.2.10.3.3.3.5	Procurement
1.2.10.3.3.4	Flammable Gas Detection Systems
1.2.10.3.3.4.1	Concept Specification
1.2.10.3.3.4.2	Conceptual Design Review
1.2.10.3.3.4.3	Engineering
1.2.10.3.3.4.4	Design
1.2.10.3.3.4.5	Procurement
1.2.10.3.3.4.6	Fabrication
1.2.10.3.3.5	Emergency Shutdown Systems
1.2.10.3.3.5.1	Concept Specification
1.2.10.3.3.5.2	Conceptual Design Review
1.2.10.3.3.5.3	Engineering
1.2.10.3.3.5.4	Design
1.2.10.3.3.5.5	Procurement
1.2.10.3.3.5.6	Fabrication
1.2.10.3.3.6	Fire Suppression Systems
1.2.10.3.3.6.1	Concept Specification

WBS Number	Descriptio
1.2.10.3.3.6.2	**Conceptual Design Review**
1.2.10.3.3.6.3	**Engineering**
1.2.10.3.3.6.4	**Design**
1.2.10.3.3.6.5	**Procurement**
1.2.10.3.3.6.6	**Fabrication**
1.2.10.3.3.7	**ODH Detection Systems**
1.2.10.3.3.7.1	**Concept Specification**
1.2.10.3.3.7.2	**Conceptual Design Review**
1.2.10.3.3.7.3	**Engineering**
1.2.10.3.3.7.4	**Design**
1.2.10.3.3.7.5	**Procurement**
1.2.10.3.3.7.6	**Fabrication**
1.2.10.3.4	**Personnel Access Systems**
	These utilities systems consist of the following elements:Scaffolding systems- this is a system of OSHA approved commercially available portable free standing scaffold to be used for personnel access to the detector for assembly and maintenance requirements. Some non-standard systems may have to be incorporated in the design for complete access
to	the detector. The majority of its use will be during long term shutdowns or multiple day maintenance activities when adequate time is required to erect and remove the scaffold system. This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.Stairs and walkways- this is a system of permanent structures incorporated into the experiment and its related subsystems to allow immediate personnel access to detector components for short term servicing and maintenance. These systems would have to meet OSHA approved standards
and	would include walkways over the experimental pit, access stairways and ladders, and elevated walkways. . This would include the cost of specification, design, procurement, and delivery of all system hardware for the experiment.
1.2.10.3.4.1	**Scaffolding Systems**
1.2.10.3.4.1.1	**Concept Specification**

WBS Number	Descriptio
1.2.10.3.4.1.2	**Conceptual Design Review**
1.2.10.3.4.1.3	**Engineering**
1.2.10.3.4.1.4	**Design**
1.2.10.3.4.1.5	**Procurement**
1.2.10.3.4.1.6	**Fabrication**
1.2.10.3.4.2	**Stairs and Walkways**
1.2.10.3.4.2.1	**Concept Specification**
1.2.10.3.4.2.2	**Conceptual Design Review**
1.2.10.3.4.2.3	**Engineering**
1.2.10.3.4.2.4	**Design**
1.2.10.3.4.2.5	**Procurement**
1.2.10.3.4.2.6	**Fabrication**
1.2.10.3.5	**Management Activities**
	This element includes the cost for the overall coordination and management of the day-to-day and long term conventional systems activities. Included is the cost of an onsite manager, engineering, design drafting, and clerical support.
1.2.10.3.5.1	**Pre-construction Effort**
1.2.10.3.5.2	**Manager**
1.2.10.3.5.3	**Engineering**
1.2.10.3.5.4	**Administration**
1.2.10.3.5.5	**Procurement**
1.2.10.3.5.5.1	**MSTS FY06**

WBS Number	Descriptio
1.2.10.3.5.5.2	**MSTS FY07**
1.2.10.3.5.5.3	**MSTS FY08**
1.2.10.3.5.5.4	**MSTS FY09**
1.2.10.3.5.5.5	**MSTS FY10**
1.2.10.3.5.5.6	**Computer Hardware/Software FY06**
1.2.10.3.5.5.7	**Computer Hardware/Software FY07**
1.2.10.3.5.5.8	**Computer Hardware/Software FY08**
1.2.10.3.5.5.9	**Computer Hardware/Software FY09**
1.2.10.3.5.5.10	**Computer Hardware/Software FY10**
1.2.10.4	**Testing & Commissioning**
	This includes the cost and schedule of all labor required for testing and commissioning the baseline KOPIO Detector in the Collider-Accelerator (C-A) experimental floor, Bldg. 912. System testing and commissioning consists of the following elements: Testing, Commissioning, Management activities.
1.2.10.4.1	**Testing**
	This element includes all labor costs associated with the testing of all detector subsystems and system tests once it has entered the C-A experimental floor at BNL. These tests can range from acceptance inspection and test of procurement deliverables through pre-operational testing of subsystems prior to commissioning. Costs for continuation of engineering and technical support of a detector subsystem by the home institution are not covered by this element. This element does not include the cost of planning the test activities of individual detector subsystems.
1.2.10.4.1.1	**Conceptual Planning**
1.2.10.4.1.2	**Conceptual Design Review**
1.2.10.4.2	**Commissioning**

WBS Number	Descriptio
	This element includes all labor costs associated with the commissioning of the KOPIO Detector and its combined
subsystems	
	as a whole once the detector installation is complete and individual subsystem testing is completed on the experimental floor. The scope of these commissioning efforts would include full experimental pre-operational testing and engineering beam studies of the beam transport with experimental detector. Costs for continuation of engineering and technical
support	
	of a detector subsystem by the home institution are not covered by this element. This element does not include the cost of planning the commissioning activities of individual detector subsystems or beam transport subsystems.
1.2.10.4.2.1	**Conceptual Planning**
1.2.10.4.2.2	**Conceptual Design Review**
1.2.10.4.3	**Management Activities**
	This element includes the cost for the overall coordination and management of the day-to-day and long term Testing and Commissioning activities. Included is the cost of an onsite testing and commissioning manager, engineering, and clerical support.
1.2.10.4.3.1	**Pre-construction Effort**
1.2.10.4.5.2	**Manager**
1.2.10.4.5.4	**Administration**
1.2.10.4.5.5	**Procurement**
1.2.10.4.5.5.1	**MSTS FY06**
1.2.10.4.5.5.2	**MSTS FY07**
1.2.10.4.5.5.3	**MSTS FY08**
1.2.10.4.5.5.4	**MSTS FY09**
1.2.10.4.5.5.5	**MSTS FY10**
1.2.10.4.5.5.6	**Computer Hardware/Software FY06**
1.2.10.4.5.5.7	**Computer Hardware/Software FY07**

WBS Number	Descriptio
1.2.10.4.5.5.8	Computer Hardware/Software FY08
1.2.10.4.5.5.9	Computer Hardware/Software FY09
1.2.10.4.5.5.10	Computer Hardware/Software FY10

WBS Number	Descriptio
1.2.11	Project Services
1.2.11.1	Project Management
1.2.11.1.1	Project Manager
1.2.11.1.2	Deputy Project Manager
1.2.11.1.3	Project Engineer
1.2.11.1.4	AGS Mods. Liaison
1.2.11.1.5	AGS Beam & Exp. Area Liaison
1.2.11.1.6	Secretary
1.2.11.2	Fiscal
1.2.11.2.1	Project Administrator
1.2.11.2.2	Schedules
1.2.11.2.3	Materials & Supplies
1.2.11.2.4	Travel
1.2.11.2.5	Communications
1.2.11.2.6	Space Charge
1.2.11.3	Computing Support
1.2.11.4	QA
1.2.11.5	Safety
1.2.11.6	Document Control